



OEM7 SPAN Installation and Operation User Manual

OEM7 SPAN Installation and Operation User Manual

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Warranty

NovAtel Inc. warrants that its GNSS products are free from defects in materials and workmanship, subject to the conditions set forth on our web site: www.novatel.com/products/warranty/ and for the following time periods:

OEM7 [®] Receivers	One (1) Year
GNSS Antenna Series	One (1) Year
Cables and Accessories	Ninety (90) Days
Software Warranty	One (1) Year

Return instructions

To return products, refer to the instructions found at: www.novatel.com/warranty-return.

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Table of Contents

OEM7 SPAN Installation and Operation User Manual

OEM7 SPAN Installation and Operation User Manual	2
Warranty	2
Return instructions	2
Proprietary Notice	2

Notices

FCC	8
Industry Canada	8
European Union (EU)	8
WEEE	8
RoHS	9
REACH	9
Ethernet Port	9
Lightning Protection Installation and Grounding Procedure	9
Conventions	11

Customer Support

NovAtel Knowledge Base	12
Before Contacting Customer Support	12
Contact Information	12

Chapter 1 Introduction to SPAN technology

1.1 Fundamentals of GNSS+INS	14
1.2 Models and Features	15
1.3 Related Documents and Information	17

Chapter 2 SPAN Installation

2.1 Hardware Description	18
2.2 Hardware Set Up	18
2.2.1 Mounting the GNSS Antenna	18
2.2.2 Mount the IMU	19
2.2.3 Connect the IMU to the OEM7 Receiver	19
IMU Direct Connection	20
Use an OEM6 Receiver Command	20
2.2.4 Connect Power	21
2.3 MIC Set Up	22
2.3.1 Install a MIC in a Stack Up Configuration	22
2.3.2 Install a MIC in a Standalone Configuration	28
2.4 UIC Set Up	33
2.4.1 Mount the SPAN System Components	35
2.4.2 Connect the IMU to the UIC	36
2.4.3 Connect the UIC to a receiver	36
2.4.4 Connect Power to the UIC and OEM7 Receiver	37
2.4.5 UIC Status LEDs	37
2.5 IMU LEDs	38

Chapter 3 SPAN Operation

3.1 Definition of Reference Frames Within SPAN	40
--	----

3.1.1	The Local-Level Frame (ENU)	40
3.1.2	The IMU Body Frame	41
3.1.3	The Vehicle Frame	41
3.1.4	The User Output Frame	42
3.2	SPAN Translations and Rotations	42
3.2.1	Translational Offsets	42
3.2.2	Rotational Offsets	44
3.3	Communicating with the SPAN System	46
3.3.1	INS Window in NovAtel Connect	47
3.4	Software Configuration	47
3.4.1	Minimum Recommended Configuration	47
3.4.2	GNSS Configuration	48
3.4.3	INS Profiles	48
3.4.4	SPAN Configuration	49
3.5	Real-Time Operation	53
3.5.1	System Start-Up and Alignment Techniques	54
3.5.2	INS Seed / Fast INS Initialization	57
	Saving	57
	Use at Boot-up	57
	Alignment Type: Bits 26-28	58
	NVM Seed Status: Bits 29-31	58
3.5.3	Navigation Mode	58
3.5.4	Data Collection	59
3.5.5	Lever Arm Calibration Routine	60
3.5.6	Body to Vehicle Frame Rotation Calibration Routine	61
3.5.7	Multi-Line Body to Vehicle Frame Rotation Calibration Routine	62
3.6	Synchronizing External Equipment	64
3.6.1	Configuring an Input Strobe	64
3.7	Adding Timed Sensor Triggers	65
3.7.1	Configuring the Hardware	65
3.7.2	Configuring the Software	66
3.7.3	Using Timed Event Pulses	66
3.7.4	Recording Incoming Sensor Events	66
3.8	SPAN Wheel Sensor Configuration	66
3.8.1	Wheel Sensor Data Collected on IMU	67
3.9	Azimuth Sources on a SPAN System	68
3.9.1	Course Over Ground	68
3.9.2	Inertial Azimuth	68
3.9.3	ALIGN Azimuth	69
3.10	Data Collection for Post Processing	69
3.11	Firmware Updates and Model Upgrades	70
3.12	Variable Lever Arm	70
3.12.1	Reference Frame Description	70
3.12.2	How to Use Variable Lever Arm	72
3.12.3	The Mount Computation Frame	74
3.13	Relative INS	76
3.13.1	Configure Relative INS	77

Chapter 4 SPAN with Dual Antenna

4.1	Installation	79
4.2	Configuring ALIGN with SPAN	80
4.3	Configuring SPAN with ALIGN	81
4.3.1	Alignment on a Moving Vessel - Aided Transfer Alignment	81
4.3.2	Alignment on a Stationary Vehicle - Aided Static Alignment	82

4.3.3 Unaided Alignment	82
4.3.4 Automatic Alignment Mode - Automatic Alignment (default)	82
4.4 SPAN ALIGN Attitude Updates	82

APPENDIX A IMU Technical Specifications

A.1 HG1700 IMU (single-connector enclosure)	84
A.1.1 HG1700 IMU Mechanical Drawings	85
A.1.2 HG1700 IMU Performance	87
A.1.3 HG1700 Electrical and Environmental	88
A.1.4 Interface Cable for the HG1700 IMU	88
A.2 IMU-CPT	89
A.2.1 IMU-CPT Mechanical Drawings	90
A.2.2 IMU-CPT Sensor Specifications	92
A.2.3 IMU-CPT Electrical and Environmental	92
A.2.4 IMU-CPT Cable	93
A.3 IMU-FSAS	95
A.3.1 IMU-FSAS Mechanical Drawings	96
A.3.2 IMU-FSAS Performance	99
A.3.3 IMU-FSAS Electrical and Environmental	99
A.3.4 Interface Cable for IMU-FSAS	100
A.3.5 IMU-FSAS Cable with Odometer	100
A.3.6 IMU-FSAS Odometer Cabling	102
A.4 IMU-HG1900	105
A.4.1 IMU-HG1900 Mechanical Drawings	106
A.4.2 IMU-HG1900 Sensor Specifications	108
A.4.3 IMU-HG1900 Electrical and Environmental	108
A.4.4 IMU-HG1900 Cables	109
A.5 IMU-IGM	110
A.5.1 IMU-IGM Mechanical Drawings	111
A.5.2 IMU-IGM Ports	113
A.5.3 IMU-IGM Sensor Specifications	114
A.5.4 IMU-IGM Electrical and Environmental	115
A.5.5 IMU-IGM Interface Cable	116
A.6 IMU-ISA-100C	118
A.6.1 IMU-ISA-100C Mechanical Drawings	119
A.6.2 Optional Side Mounting Holes	120
A.6.3 IMU-ISA-100C Performance	122
A.6.4 IMU-ISA-100C Electrical and Environmental	122
A.6.5 IMU Enclosure Interface Cable	123
A.6.6 IMU Enclosure Power Cable	124
A.6.7 IMU Enclosure Wheel Sensor Cable	125
A.7 IMU-KVH1750 / IMU-KVH1725	129
A.7.1 IMU-KVH1750 / IMU-KVH1725 Mechanical Drawings	130
A.7.2 IMU-KVH1750 / IMU-KVH1725 Sensor Specifications	134
A.7.3 IMU-KVH1750 / IMU-KVH1725 Electrical and Environmental	135
A.7.4 IMU-KVH1750 / IMU-KVH1725 Cable	136
A.8 IMU-LN200	138
A.8.1 IMU-LN200 Mechanical Drawings	139
A.8.2 IMU-LN200 Sensor Specifications	141
A.8.3 IMU-LN200 Electrical and Environmental	142
A.8.4 IMU-LN200 Cables	142
A.9 IMU- μ IMU	143
A.9.1 IMU- μ IMU Mechanical Drawings	144
A.9.2 IMU- μ IMU Sensor Specifications	146
A.9.3 IMU- μ IMU Electrical and Environmental	146

A.9.4	IMU- μ IMU Cables	147
A.10	LN-200 IMU (single-connector enclosure)	148
A.10.1	LN-200 IMU Mechanical Drawings	149
A.10.2	LN-200 IMU Performance	151
A.10.3	LN-200 Electrical and Environmental	151
A.10.4	Interface Cable for the LN-200 IMU	152
A.11	OEM-IMU-ADIS-16488	153
A.11.1	OEM-IMU-ADIS-16488 Mechanical Drawings	154
A.11.2	OEM-IMU-ADIS-16488 Sensor Specifications	156
A.11.3	OEM-IMU-ADIS-16488 Electrical and Environmental	156
A.11.4	ADIS-16488 IMU-to-MIC Cable Assembly	156
A.12	OEM-IMU-ISA-100C	158
A.12.1	OEM-IMU-ISA-100C Mechanical Drawings	159
A.0.1	OEM-IMU-ISA-100C Sensor Specifications	161
A.12.2	OEM-IMU-ISA-100C Electrical and Environmental	161
A.12.3	OEM-IMU-ISA-100C IMU to UIC Cable Assembly	162
A.13	OEM-IMU-STIM300	165
A.13.1	OEM-IMU-STIM300 Mechanical Drawings	166
A.13.2	OEM-IMU-STIM300 Sensor Specifications	167
A.13.3	OEM-IMU-STIM300 Electrical and Environmental	167
A.13.4	STIM300 IMU-to-MIC Cable Assembly	167
A.14	OEM-IMU- μ IMU	169
A.14.1	OEM-IMU- μ IMU Mechanical Drawings	169
A.14.2	OEM-IMU- μ IMU Sensor Specifications	171
A.14.3	OEM-IMU- μ IMU Electrical and Environmental	172
A.0.2	μ IMU to UIC Cable Assembly	172
A.15	Universal IMU Enclosure (HG1700, LN200)	174
A.15.1	Universal IMU Enclosure Mechanical Drawings	175
A.15.2	IMU Performance	179
A.15.3	Electrical and Environmental	180
A.15.4	Universal IMU Enclosure Interface Cable	181
A.16	MIC - MEMS Interface Card	184
A.16.1	MIC Mechanical Drawings	185
A.16.2	MIC Electrical and Environmental	187
A.16.3	MIC Connectors	187
A.16.4	HG1930 IMU-to-MIC Cable Assembly	193
A.16.5	HG1700 and HG1900 IMU-to-MIC Cable Assembly	194
A.17	UIC - Universal IMU Controller	196
A.17.1	UIC Mechanical Drawings	197
A.17.2	UIC Electrical and Environmental	199
A.17.3	UIC Connectors	199
A.0.3	HG1900 IMU to UIC Cable Assembly	202
A.0.4	LN200 IMU to UIC Cable Assembly	203

APPENDIX B HG1700 IMU in Universal Enclosure

B.1	Disassemble the Universal Enclosure	207
B.2	Install the HG1700 Sensor Unit	209

APPENDIX C LN-200 IMU in Universal Enclosure

C.1	Disassemble the Universal Enclosure	217
C.2	Install the LN-200 Sensor Unit	219

APPENDIX D HG1700 IMU in SPAN HG Enclosure

D.1	Disassemble the SPAN IMU Enclosure	224
-----	--	-----

D.2	Install the HG1700 Sensor Unit	226
D.3	Make the Electrical Connections	227
D.4	Re-Assemble the SPAN IMU Enclosure	229

APPENDIX E LN-200 IMU in SPAN IMU Enclosure

E.1	Disassemble the SPAN IMU Enclosure	231
E.2	Install the LN-200 Sensor Unit	233
E.3	Make the Electrical Connections	234
E.4	Re-Assemble the SPAN IMU Enclosure	236

APPENDIX F Frequently Asked Questions

APPENDIX G Replacement Parts for SPAN

Notices

The following notices apply, as appropriate, to the OEM7 family products.



Changes or modifications to this equipment, not expressly approved by NovAtel Inc., could void the user's authority to operate this equipment.

FCC

The devices covered by this manual comply with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. The Class B limits are designed to provide reasonable protection against harmful interference in a residential installation. The equipment listed generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

Industry Canada

OEM7 Class B digital apparatus comply with Canadian ICES-003.

OEM7 appareils numérique de la classe B sont conforme à la norme NMB-003 du Canada.

European Union (EU)

Hereby, NovAtel Inc. declares that the radio equipment type OEM7 GNSS receiver is in compliance with Directive 2014/53/EU


The full text of the EU Declaration of Conformity may be obtained from the NovAtel website at: www.novatel.com/products/compliance/eu-declaration-of-conformity/.

WEEE

If you purchased your OEM7 family product in Europe, please return it to your dealer or supplier at the end of life. The objectives of the European Community's environment policy are, in particular, to preserve, protect and improve the quality of the environment, protect human health

and utilise natural resources prudently and rationally. Sustainable development advocates the reduction of wasteful consumption of natural resources and the prevention of pollution. Waste Electrical and Electronic Equipment (WEEE) is a regulated area. Where the generation of waste cannot be avoided, it should be reused or recovered for its material or energy. WEEE products



may be recognized by their wheeled bin label (). See www.novatel.com/products/compliance/environmental-compliance/ for more information.

RoHS

The OEM7 GNSS receivers are in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

REACH

The OEM7 receivers are in compliance with Regulation (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH). The Candidate List of Substances of Very High Concern (SVHC) published by the European Chemical Agency (ECHA) is available at <https://echa.europa.eu/candidate-list-table>. Please contact NovAtel Customer Support if you require further information.

Ethernet Port



The Ethernet ports are Safety Extra Low Voltage (SELV) circuits only and are suitable for connection within a building only. Do not connect them to Telephone Network Voltage (TNV) circuits.

Lightning Protection Installation and Grounding Procedure

What is the hazard?

A lightning strike into the ground causes an increase in the earth's potential which results in a high voltage potential between the center conductor and shield of the coaxial cable. This high voltage develops because the voltage surge induced onto the center conductor lags in time behind the voltage surge induced onto the shield.

Hazard Impact

A lightning strike causes the ground potential in the area to rise to dangerous levels resulting in harm to personnel or destruction of electronic equipment in an unprotected environment. It also conducts a portion of the strike energy down the inner conductor of the coaxial cable to the connected equipment.



Only qualified personnel, such as electricians mandated by the governing body in the country of installation, may install lightning protection devices.

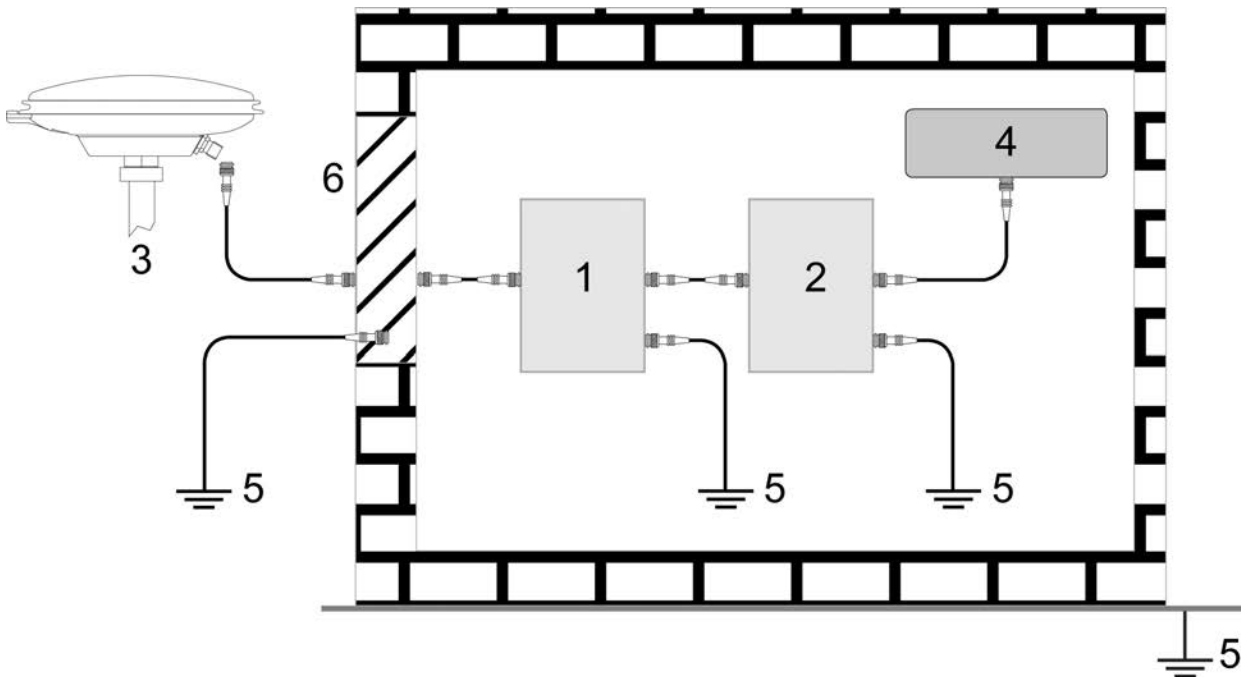
Actions to Mitigate Lightning Hazards

1. Do not install antennas or antenna coaxial cables outside the building during a lightning storm.
2. It is not possible to avoid over voltages caused by lightning, but a lightning protection device may be used to shunt a large portion of the transient energy to the building ground, reducing the over voltage condition as quickly as possible.
3. Primary lightning protection must be provided by the operator/customer according to local building codes as part of the extra building installation.
4. To ensure compliance with clause 7 "Connection to Cable Distribution Systems" of EN 60950-1, Safety for Information Technology Equipment, a secondary lightning protection device must be used for in-building equipment installations with external antennas. The following device has been approved by NovAtel Inc.:

Polyphaser - Surge Arrestor DGXZ+24NFN-B

If this device is not chosen as the primary lightning protection device, the device chosen must meet the following requirements:

- UL listed, or equivalent, in country of installation (for example, TUV, VDE and so on) for lightning surge protection
 - The primary device must be capable of limiting an incoming surge to 10 kV
5. The shield of the coaxial cable entering the building should be connected at a grounding plate at the building's entrance. The lightning protection devices should have their chassis grounded to the same ground near to the building's entrance.
 6. The primary and secondary lightning protections should be as close to the building's entrance as possible. Where feasible, mount onto the grounding plate itself (refer to the figure below).



Ref #	Description
1	Primary lightning protection device
2	Secondary lightning protection device
3	External antenna
4	GNSS Receiver
5	To ground
6	Grounding plate or grounding point at the building's entrance



Acceptable choices for earth grounds, for central buildings, are:

- Grounded interior metal cold water pipe within five feet (1.5 m) of the point where it enters the building
- Grounded metallic service raceway
- Grounded electrical service equipment enclosure
- Eight-foot grounding rod driven into the ground (only if bonded to the central building ground by #6, or heavier, bonding wire)

These installation instructions are the minimum requirements for receiver and antenna installations. Where applicable, follow the electrical codes for the country of installation. Examples of country codes include:

- **USA** National Electrical Code (NFPA 70)
- **Canada** Canadian Electrical Code (CSA C22)
- **UK** British Standards Institute (BSI 7671)

Conventions

The following conventions are used in this manual:



Information that supplements or clarifies text.



A caution that actions, operation or configuration may lead to incorrect or improper use of the hardware.



A warning that actions, operation or configuration may result in regulatory noncompliance, safety issues or equipment damage.

Customer Support

NovAtel Knowledge Base

If you have a technical issue, visit the NovAtel Support page at www.novatel.com/support. Through the *Support* page, you can contact Customer Support, find papers and tutorials or download current manuals and the latest firmware.

Before Contacting Customer Support

Before you contact NovAtel Customer Support about a software problem, perform the following steps:



If logging data over an RS-232 serial cable, ensure that the configured baud rate can support the data bandwidth (see **SERIALCONFIG** command). NovAtel recommends a minimum suggested baud rate of 115200 bps.

1. Log the following data to a file on your computer for 15 minutes:

```
RXSTATUSB once
RAWEPHEMB onchanged
GLORAWEPHEMB onchanged
BESTPOSB ontime 1
RANGEB ontime 1
RXCONFIGA once
VERSIONA once
```

For SPAN systems, include the following logs in the file created on your computer:

```
RAWIMUSXB onnew
INSUPDATESTATUSB onnew
INSPVAXB ontime 1
INSCONFIGA once
```

2. Send the data file to NovAtel Customer Support: support@novatel.com
3. You can also issue a **FRESET** command to the receiver to clear any unknown settings.



The **FRESET** command will erase all user settings. You should know your configuration (by requesting the RXCONFIGA log) and be able to reconfigure the receiver before you send the **FRESET** command.

If you are having a hardware problem, send a list of the troubleshooting steps taken and the results.

Contact Information

Log a support request with NovAtel Customer Support using one of the following methods:

Log a Case and Search Knowledge:

Website: www.novatel.com/support

Log a Case, Search Knowledge and View Your Case History: (login access required)

Web Portal: <https://novatelsupport.force.com/community/login>

E-mail:

support@novatel.com

Telephone:

U.S. and Canada: 1-800-NOVATEL (1-800-668-2835)

International: +1-403-295-4900

Chapter 1 Introduction to SPAN technology

NovAtel's SPAN technology brings together two very different but complementary positioning and navigation systems namely Global Navigation Satellite System (GNSS) and an Inertial Navigation System (INS). By combining the best aspects of GNSS and INS into one system, SPAN technology is able to offer a solution that is more accurate and reliable than either GNSS or INS could provide alone. The combined GNSS+INS solution has the advantage of the absolute accuracy available from GNSS and the continuity of INS through traditionally difficult GNSS conditions.

The SPAN system consists of the following components:

- NovAtel OEM7 receiver
These receivers are capable of receiving and tracking different combinations of GPS, GLONASS, Galileo and BeiDou signals on a maximum of 555 channels. OEM7 family receivers can also allocate channels for the reception of correction service signals from SBAS (standard) and NovAtel Correct™ with PPP (optional). OEM7 adaptability offers multi-system, frequency, and size configurations for any application requirement. Patented Pulsed Aperture Correlator (PAC) technology combined with a powerful microprocessor enable multipath-resistant processing. Excellent acquisition and re-acquisition times allow this receiver to operate in environments where very high dynamics and frequent interruption of signals can be expected. The OEM7 family also supports the timing requirements of the IMU and runs the real-time INS filter.
- IMU
The Inertial Measurement Unit (IMU) consists of three accelerometers and three gyroscopes (gyros) so that accelerations along specific axis and angular rotations can be measured. Several IMU types are supported and are listed in *Table 1: SPAN-Compatible IMU Models* on the next page.
- GNSS antenna
- Computer Software
Real-time data collection, status monitoring and receiver configuration is possible through the NovAtel Connect™ software utility, see *SPAN Configuration with NovAtel Connect* on page 52.

The GNSS receiver is connected to the IMU with an RS-232, RS-422 or SPI link. A NovAtel GNSS antenna must also be connected to the receiver to track GNSS signals. After the IMU enclosure, GNSS antenna and appropriate power supplies are attached, and a few simple configuration commands are entered, the SPAN system will be ready to navigate.

1.1 Fundamentals of GNSS+INS

GNSS positioning observes range measurements from orbiting GNSS satellites. From these observations, the receiver can compute position and velocity with high accuracy. NovAtel GNSS positioning systems are highly accurate positioning tools. However, GNSS in general has some restrictions which limit its usefulness in some situations. GNSS positioning requires line of sight view to at least four satellites simultaneously. If these criteria are met, differential GNSS positioning can be accurate to within a few centimetres. If however, some or all of the satellite signals are blocked, the accuracy of the position reported by GNSS degrades substantially, or may not be available at all.

In general, an INS uses forces and rotations measured by an IMU to calculate position, velocity and attitude. This capability is embedded in the firmware of OEM7 series receivers. Forces are measured by accelerometers in three perpendicular axes within the IMU and the gyros measure angular rotation rates around those axes. Over short periods of time, inertial navigation gives very accurate acceleration, velocity and attitude output. The INS must have prior knowledge of its initial position, initial velocity, initial attitude, Earth rotation rate and gravity field. Since the IMU measures changes in orientation and acceleration, the INS determines changes in position and attitude, but initial values for these parameters must be provided from an external source. Once these parameters are known, an INS is capable of providing an autonomous solution with no external inputs. However, because of errors in the IMU measurements that accumulate over time, an inertial-only solution degrades with time unless external updates such as position, velocity or attitude are supplied.

The SPAN system's combined GNSS+INS solution integrates the raw inertial measurements with all available GNSS information to provide the optimum solution possible in any situation. By using the high accuracy GNSS solution, the IMU errors can be modeled and mitigated. Conversely, the continuity and relative accuracy of the INS solution enables faster GNSS signal reacquisition and RTK solution convergence.

The advantages of using SPAN technology are its ability to:

- Provide a full attitude solution (roll, pitch and azimuth)
- Provide continuous solution output (in situations when a GNSS-only solution is impossible)
- Provide faster signal reacquisition and RTK solution resolution (over stand-alone GNSS because of the tightly integrated GNSS and INS filters)
- Output high-rate (up to 200 Hz depending on your logging selections) position, velocity and attitude solutions for high-dynamic applications, see also *Logging Restriction Important Notice* on page 60
- Use raw phase observation data (to constrain INS solution drift even when too few satellites are available for a full GNSS solution)



For more information about GNSS and INS, refer to www.novatel.com/an-introduction-to-gnss/

1.2 Models and Features

All SPAN system receivers are factory configurable for L1/L2 RTK capability and are compatible with an IMU. See *Table 1: SPAN-Compatible IMU Models* below for firmware model details.

Table 1: SPAN-Compatible IMU Models

Model Name	Compatible IMUs	SW Model
IMU-CPT	IMU-CPT	S1
IMU-FSAS-EI	iIMU-FSAS	S3
IMU-H1900-CA50	HG1900-CA50	S2

Model Name	Compatible IMUs	SW Model
IMU-H1930-CA50	HG1930-CA50	S1
IMU-H58	HG1700-AG58	S2
IMU-H62	HG1700-AG62	S2
IMU-IGM-A1	IMU-IGM-A1	S1
IMU-IGM-S1	IMU-IGM-S1	S1
IMU-ISA-100C	ISA-100C	S3
IMU-KVH1725	KVH-1725	S2
IMU-KVH1750	KVH-1750	S2
IMU-LN200	LN-200	S3
IMU- μ IMU	Lifef μ IMU	S2
OEM-IMU-ADIS-16488	OEM-IMU-ADIS-16488	S1
OEM-IMU-G320	OEM-IMU-G320	S1
OEM-IMU-ISA-100C	OEM-IMU-ISA-100C	S3
OEM-IMU-STIM300	OEM-IMU-STIM300	S1
UIMU-H58	HG1700-AG58	S2
UIMU-H62	HG1700-AG62	S2

Each model is capable of multiple positioning modes of operation.

Each model has the following standard features:

- NovAtel's advanced OEM7 multi-frequency, multi-constellation receiver
- Full-duplex COM ports which support data transfer rates of up to 460,800 bits/s¹. One of these serial ports is capable of communication with an IMU
- USB 2.0 port
- Ethernet port
- Controller Area Network Bus (CAN Bus) which is a rugged differential serial bus with a protocol that provides services for processes, data and network management.
- Field-upgradeable firmware (program software). This unique feature means that the firmware can be updated any time, anywhere, without any mechanical procedures whatsoever. Firmware upgrades can include changes in the software model to enable additional features or signals. For example, a model with L1/L2-only capabilities can be upgraded to a model with L1/L2 and NovAtel CORRECT with RTK™ in only a few minutes in your office (instead of the days or weeks that would be required if the receiver had to be sent to a service depot).

¹Rates higher than 115,200 are not standard on most computers and may require extra computer hardware.

All that is required to unlock the additional features is a special authorization code. Refer to the OEM7 Installation and Operation User Manual (OM-20000168) for further details on this topic.

Some of the IMUs used with SPAN are housed in an enclosure with a PCB board to handle power, communication and data timing. See *IMU Technical Specifications* on page 83 for details.

1.3 Related Documents and Information

This manual contains sufficient information about the installation and operation of the SPAN system. It is beyond the scope of this manual to provide details on service or repair. Contact your local NovAtel dealer for any customer service related inquiries, see *Customer Support* on page 12.

The OEM7 receiver utilizes a comprehensive user-interface command structure, which requires communications through its communications ports. For descriptions of the commands and logs available with OEM7 family products, refer to the OEM7 Commands and Logs Reference Manual (OM-20000169) available on the NovAtel website at www.novatel.com/support/. It is recommended that these documents be kept together for easy reference.

For more information about the OEM7 receivers, refer to the OEM7 Installation and Operation User Manual (OM-20000168).

SPAN system output is compatible with post-processing software from NovAtel's Waypoint® Products Group. Visit our web site at www.novatel.com for details.

Chapter 2 SPAN Installation

2.1 Hardware Description

One hardware setup consists of an OEM7 receiver, an IMU, a GNSS antenna, power and a communication link (if your application requires real time differential operation).



If your IMU enclosure and IMU were supplied separately, additional instructions for installing the IMU into the enclosure are available in the following appendices: *HG1700 IMU in Universal Enclosure* on page 206, *LN-200 IMU in Universal Enclosure* on page 217, *HG1700 IMU in SPAN HG Enclosure* on page 224 and *LN-200 IMU in SPAN IMU Enclosure* on page 231.

Another hardware set up consists of a receiver, an IMU, an IMU interface card, a GNSS antenna and a COM and power link. The IMU interface card can be a MEMS Interface Card (MIC) (refer to *MIC Set Up* on page 22) or a Universal IMU Controller (UIC) (refer to *UIC Set Up* on page 33).

2.2 Hardware Set Up

Complete the following steps to set up your NovAtel SPAN system.

1. Mount the GNSS antenna.

See *Mounting the GNSS Antenna* below for details.

2. Mount the IMU.

See *Mount the IMU* on the next page for details.

3. Install the OEM7 receiver.

See the OEM7 Installation and Operation User Manual (OM-20000168) for information about installing an OEM7 receiver.

4. Connect the GNSS antenna to the OEM7 receiver.

See the OEM7 Installation and Operation User Manual (OM-20000168) for information about installing an OEM7 receiver.

5. Connect the IMU to the OEM7 receiver.

See *Connect the IMU to the OEM7 Receiver* on the next page for details.

6. Connect the I/O strobe signals (optional).

See the OEM7 Installation and Operation User Manual (OM-20000168) for information about installing an OEM7 receiver.

7. Connect power to the IMU and receiver.

See *Connect Power* on page 21 for details.

2.2.1 Mounting the GNSS Antenna

The OEM7 receiver is designed to operate with any of the NovAtel single, dual and triple-frequency GNSS antenna models.

When installing the antenna:

- Choose an antenna location with a clear view of the sky so each satellite above the horizon can be tracked without obstruction. For more information on RF signal propagation and multipath, refer to the NovAtel application note [APN-008 Discussions on RF Signal Propagation and Multipath](http://www.novatel.com/support/APN-008_Discussions_on_RF_Signal_Propagation_and_Multipath) at www.novatel.com/support/.
- Mount the antenna on a secure, stable structure capable of safe operation in the specific environment.
- Ensure the antenna cannot move due to dynamics.

2.2.2 Mount the IMU

Mount the IMU in a fixed location where the distance from the IMU to the GNSS antenna phase center is constant. Ensure that the orientation with respect to the vehicle and antenna is also constant.

For attitude output to be meaningful, the IMU should be mounted such that the positive Z-axis marked on the IMU enclosure points up and the Y-axis points forward through the front of the vehicle, in the direction of track. If the IMU is not mounted in this orientation, a rotational offset must be applied. See *Rotational Offsets* on page 44 for more information.

Also, it is important to measure the distance from the IMU to the antenna (the Antenna Lever Arm), on the first usage, on the axis defined on the IMU enclosure. See *Lever Arm Calibration Routine* on page 60. See also *IMU Technical Specifications* on page 83 for dimensional drawings of the IMU enclosures.

Ensure the IMU cannot move due to dynamics and that the distance and relative direction between the antenna and the IMU is fixed. See *SPAN Configuration* on page 49.



The closer the antenna is to the IMU, particularly in the horizontal plane, the more accurate the position solution. Also, your measurements entered using the **SETINSTRANSLATION** command must be as accurate as possible, or at least more accurate than the GNSS positions being used. **For example, a 10 cm error in recording the antenna offset will result in at least a 10 cm error in the output. Millimeter accuracy is preferred.**

The offset from the IMU to the antenna, and/or a user point device, must remain constant especially for RTK or DGPS data. Ensure the IMU, antenna and user point device are bolted in one position perhaps by using a custom bracket.

2.2.3 Connect the IMU to the OEM7 Receiver

Connect the IMU to the receiver using the IMU interface cable.

For a system with a OEM7 receiver card:

- A wiring harness is required between the receiver card and the IMU interface cable. For more information, see the OEM7 Installation and Operation User Manual (OM-20000168).



If using a KVH1725 or KVH1750 IMU, the baud rate of the IMU must be changed to 460,800 bps. For information about changing the IMU baud rate, see *IMU Direct Connection* on the next page.

KVH1725 and KVH1750 Baud Rate Conversion

The maximum baud rate of the COM ports on an OEM7 receiver is 460,800 bps. The KVH1750 and KVH1725 IMUs natively communicate at 921,600 bps, so they need to be modified to use 460,800 bps.



Though slower, 460,800 bps is more than adequate to transmit the data at the required 200 Hz without any impact to performance.

There are two methods to change the KVH17xx series IMU baud rate. If an OEM6 receiver is available, a command is available that will allow the receiver to change the IMU baud rate. If not, a direct RS-422 connection at 921,600 baud is required to change the IMU baud rate.

IMU Direct Connection



This method requires a direct connection to the IMU at 921,600 baud over RS-422. Make sure the RS-422 link used is capable of 921,600 baud as not all serial ports are capable of that rate.

1. Open a command terminal at 921600 baud via an RS-422 serial link.
By default, the IMU will output 0.5 Hz binary messages which will help confirm you are connected properly.
2. Issue the following two commands in sequence to enter configuration mode and change the baud rate.


```
=CONFIG,1
=BAUD,460800
```
3. Upon completion of these commands, power cycle the IMU to boot up in the new baud rate.
4. Confirm the change by connecting to the IMU at 460,800 baud and verifying the incoming messages.

The new baud rate configuration is saved to the IMU NVM automatically so the process is complete and the IMU is ready for use with an OEM7 receiver.

Use an OEM6 Receiver Command

OEM6 firmware as of version OEM060630RN0000 (Dec 2016) includes the **IMUCONFIGURATION** command that internally configures the KVH17xx IMU for SPAN communication. Three sets of configuration options are available, two of which will allow user to change the baud rate of the IMU to either 921,600 or 460,800. This provides customers upgrading to OEM7 an easy method to modify the baud rate. To change the IMU to 460800 baud, use the following procedure:

1. Connect the KVH-17xx IMU (IMU-KVH1750 or IMU-KVH1725) to an RS422 capable OEM6 receiver communication port.
2. Issue the following command.

```
CONNECTIMU COM# IMU_KVH_17xx
```

3. Issue the following command.

```
IMUCONFIGURATION IMU_KVH_17xx 2
```

The **IMUCONFIGURATION** command can be used to configure the KVH17xx IMU's depending on the value of the Option field.

```
IMUCONFIGURATION IMUType [Option]
```

IMU Type	Option	Configuration Details
IMU_KVH_1750	0	Configure KVH options for NovAtel communication.
	1	Change KVH baud rate to 921,600
IMU_KVH_1725	2	Change KVH baud rate to 460,800

2.2.4 Connect Power



If you are using a MEMS OEM IMU (ADIS-16488, HG1900, HG1930, STIM300) and a MIC, see *MIC Set Up* on the next page for information about connecting and powering the MIC and IMU.



If you are using an OEM IMU (ISA-100C, HG1900, LN200 or μ IMU) and a UIC, see *UIC Set Up* on page 33 for information about connecting and powering the UIC and IMU.

Receiver Power

For information about connecting power to an OEM7 receiver, see the OEM7 Installation and Operation User Manual (OM-20000168).

IMU Power

In addition to the receiver power supply, a power supply is needed for the IMU. See *Table 2: IMU Power Supply* below for the voltage requirements for each IMU. The same power supply can be used for the receiver and the IMU, if the power supply meets the power requirements of both devices.

Table 2: IMU Power Supply

IMU	Power Requirement
UIMU-LN200	+12 to +28 V DC
IMU-ISA-100C	+10 to +34 V DC
UIMU-HG1700 (AG58 or AG62)	+12 to +28 V DC
IMU-KVH-1725	+9 to +36 V DC
IMU-KVH1750	+9 to +36 V DC
IMU-FSAS	+10 to +34 V DC
IMU-CPT	+9 to +18 V DC
IMU-IGM	+10 to +30 V DC

For most IMUs, connect the power leads on the IMU interface cable to the IMU power supply. For an IMU in the IMU Enclosure (IMU-HG1900, IMU-ISA-100C, IMU-LN200 or IMU- μ IMU), connect the IMU Power Cable (NovAtel part # 60723136) from the IMU to the IMU power supply.

Details about the IMU ports and cables can be found in *IMU Technical Specifications* on page 83.

2.3 MIC Set Up

For IMUs that are not mounted inside a NovAtel IMU enclosure (e.g. OEM-HG1930), an interface card is required to connect the IMU to the OEM7 receiver. The MEMS Interface Card (MIC) provides the connection between OEM7 receiver cards and Micro Electromechanical Systems (MEMS) IMUs.



IMUs have different interface requirements. Use a MIC to connect MEMS IMUs (ADIS-16488, HG-1700, HG-1900, HG-1930 or STIM-300) to an OEM7 receiver. For other supported IMUs (e.g. ISA100C, LN200, HG-1900 or μ IMU), use a Universal IMU Controller (UIC). See *UIC Set Up* on page 33.

There are two MIC configurations: stack up and standalone. In a stack up configuration, the MIC card is mounted on an OEM719 receiver. In a standalone configuration, the MIC is mounted separately from the receiver.



The MIC supports all OEM7 receiver cards for communications. The OEM719 is the only OEM7 receiver card that can be directly integrated and powered by the MIC.

2.3.1 Install a MIC in a Stack Up Configuration

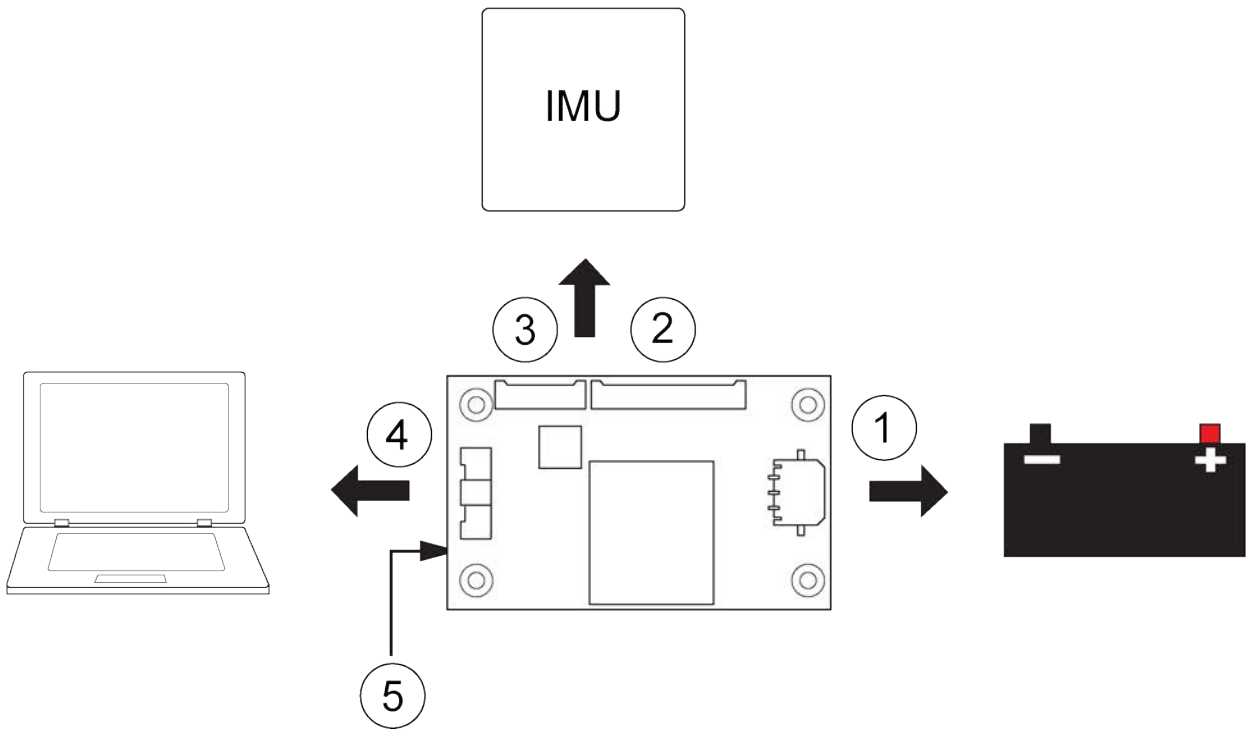
In a stack up configuration, the MIC is connected to an OEM719 receiver using the 20-pin header on the OEM719. Power and communications connections to the receiver are made through the MIC.



Important! Assemble in accordance with applicable industry standards. Ensure all Electrostatic Discharge (ESD) measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the MIC, receiver and IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces and the IMU.

For more information about ESD practices, see the OEM7 Installation and Operation User Manual (OM-20000168).

Figure 1: Basic Set Up – MIC in Stack Up Configuration



Ref	Connector	Part Number	Mating Connector	Description
1	P101	43650-0313 (Molex)	43645-0300 (Molex)	Connects to the MIC power supply. This connection provides power to the MIC and the OEM719 receiver. (user supplied cable)
2	P601	53780-2070 (Molex)	51146-2000 (Molex)	Connects to HG1700, HG1900, HG1930 and STIM300 IMUs. (NovAtel supplied cable kit)
3	P701	53780-1070 (Molex)	51146-1000 (Molex)	Connects to ADIS-16488 IMUs. (NovAtel supplied cable kit)
4	P301	501571-3007 (Molex)	501189-3010 (Molex)	Connects the MIC and OEM719 communication signals to the user system. (user supplied cable)
5	J301	ASP-163577-01 (Samtec)	N/A	Connects to the main connector (P1701) on an OEM719 receiver. J301 is on the bottom of the MIC card



For information about the MIC connectors and pin-outs, see *MIC Connectors* on page 187.



For information about the OEM7 receiver card connectors and pinouts, refer to the OEM7 Installation and Operation User Manual (OM-20000168).

Use the following steps to install the OEM719 receiver and MIC:

1. Mount the components of the SPAN system. See *Mount the SPAN System Components* below.
2. Connect the IMU to the MIC. See *Connect the IMU to the MIC* on page 30.
3. Connect power to the MIC. See *Connect Power to the MIC* on page 27.
4. Connect the input and output signals to the MIC. See *Connect the Input and Output Signals* on page 27.

Mount the SPAN System Components

1. Mount the antenna. See *Mounting the GNSS Antenna* on page 18.
2. Use the standoffs supplied with the MIC card to secure the OEM719 to its mounting location. See Figure 17, *Mount the MIC on the OEM615* on page 44. See the OEM7 Installation and Operation User Manual (OM-20000168) for information about installing an OEM7 receiver.



The part number for the recommended standoffs is RAF-M21073005AL7 (Irwin Industrial).

If alternate standoffs are selected, use equivalent parts with a minimum height of 12 mm.



Ensure all standoffs are properly installed and the mounting location is flat. The amount of board deflection (bow and twist) must not exceed 0.75%. For example, on the MIC which is 75 mm long and 46 mm wide, the deflection along the length must not exceed 0.56 mm and the deflection along the width must not exceed 0.34 mm.



Ensure the MIC is mounted close enough to the IMU so the interface cable can reach both devices.

3. Connect the antenna cable to the antenna jack on the OEM719.

The antenna cable must have a right angle MCX connector on the end that connects to the OEM719.

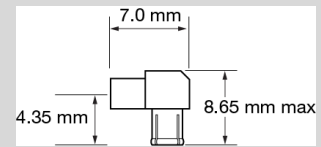


Warning! Do not apply power to the cards until the antenna cable is attached.



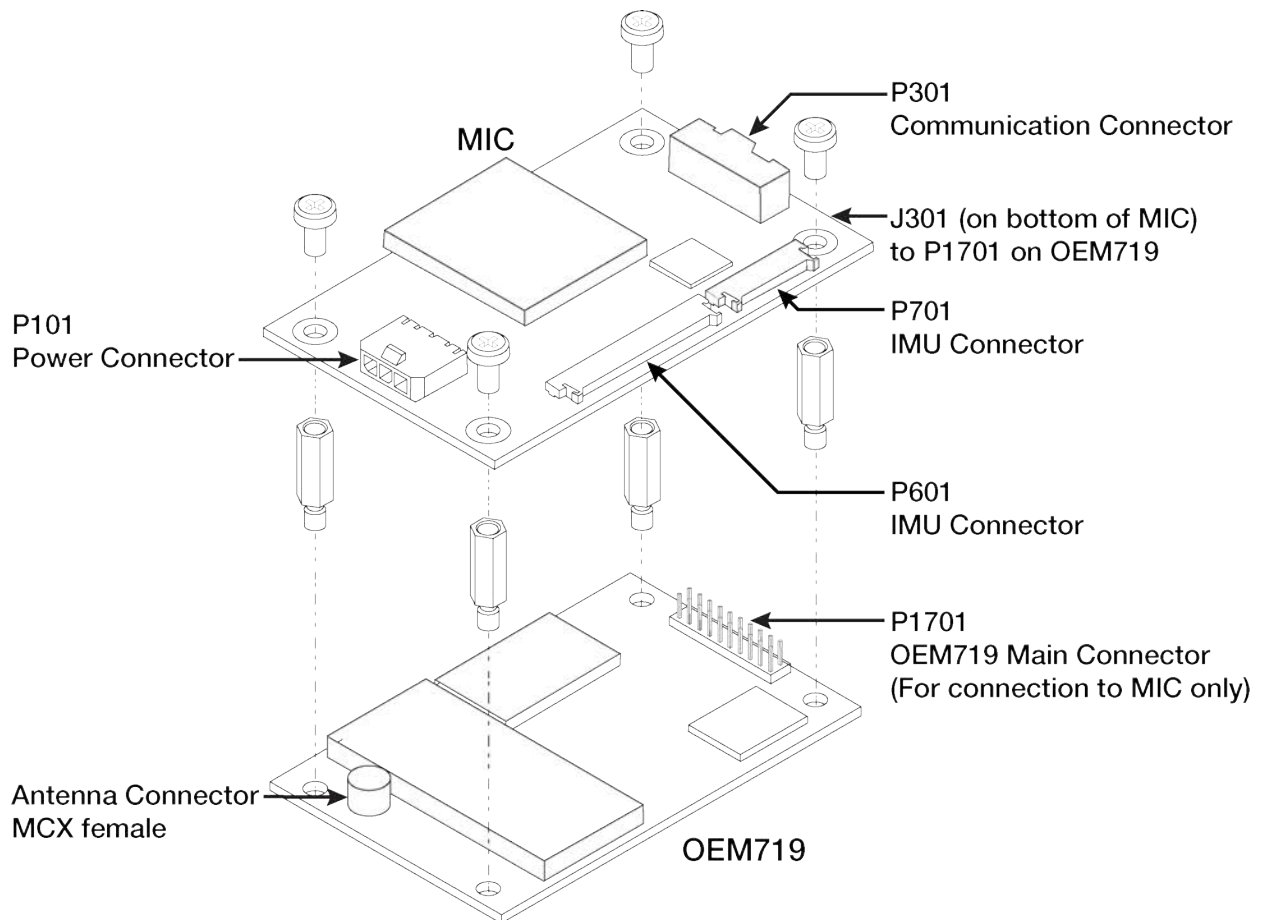
The part number for the recommended MCX connector is M1051-110 (ShinA Telecom). If an alternate part is used, it should meet the dimensions shown in the diagram.

The space between the OEM719 and the MIC is limited. The height of the MCX connector must not exceed 8.65 mm.



4. Align the mating connector (J301) on the MIC with the 20-pin header (P1701) on the OEM719. Make sure all of the pins on the header are aligned with the holes in the mating connector. Press down on the MIC to seat the connector on the header.
5. Use the four screws supplied with MIC to secure the MIC card to the OEM719.

Figure 2: Mount the MIC on the OEM719



Connect the IMU to the MIC

1. Attach the IMU mounting Printed Circuit Board (PCB) to the IMU. Ensure all the pins on the header are aligned with the holes on the mating connector.



An IMU mounting PCB is not used with the STIM300 IMU.

2. Mount the IMU. See *Mount the IMU* on page 19.
3. Connect the IMU-to-MIC interface cable to the IMU.
4. Connect the IMU-to-MIC interface cable to the IMU connector on the MIC.
 - Use the 10 pin locking connector (P701) for the ADIS IMUs.
See *Figure 3: Connect the ADIS IMU to the MIC (OEM Cable Kit: 01019007)* below.
 - Use the 20 pin locking connector (P601) for the HG1700, HG1900, HG1930 or STIM300 IMU.
See *Figure 4: Connect the HG1700 IMU to the MIC (OEM Cable Kit: 01018868)* below, *Figure 5: Connect the HG1900 IMU to the MIC (OEM Cable Kit: 01018871)* on the next page, *Figure 6: Connect the HG1930 IMU to the MIC (OEM Cable Kit: 01018869)* on the next page or *Figure 7: Connect the STIM300 IMU to the MIC (OEM Cable Kit: 01019174)* on the next page.

Figure 3: Connect the ADIS IMU to the MIC (OEM Cable Kit: 01019007)

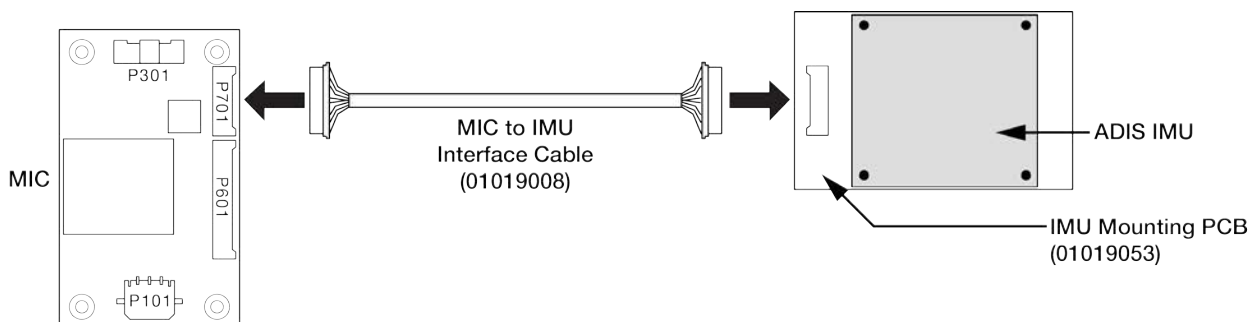


Figure 4: Connect the HG1700 IMU to the MIC (OEM Cable Kit: 01018868)

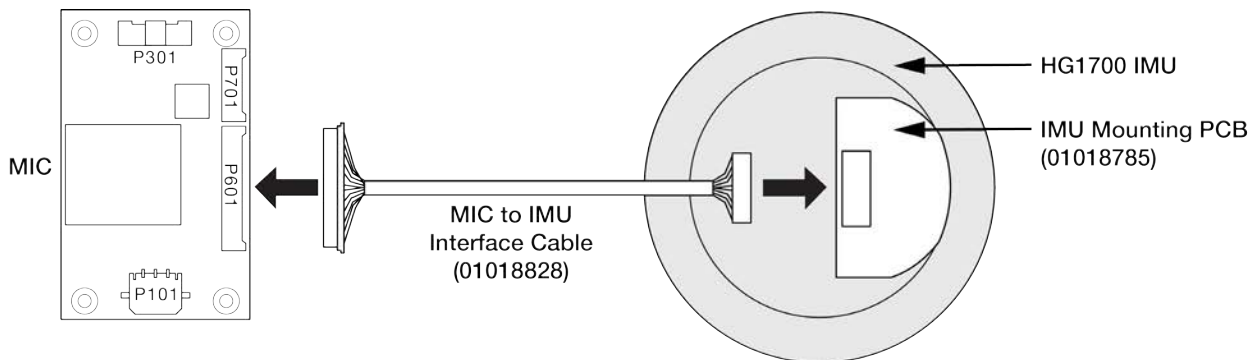


Figure 5: Connect the HG1900 IMU to the MIC (OEM Cable Kit: 01018871)

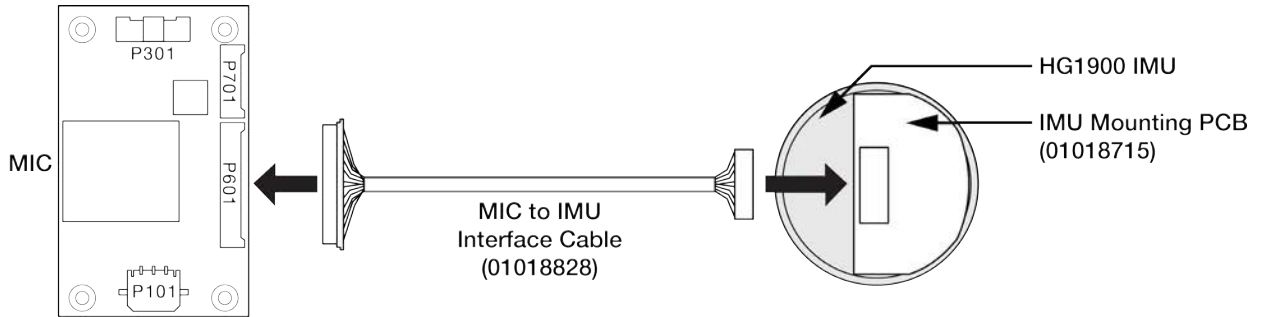


Figure 6: Connect the HG1930 IMU to the MIC (OEM Cable Kit: 01018869)

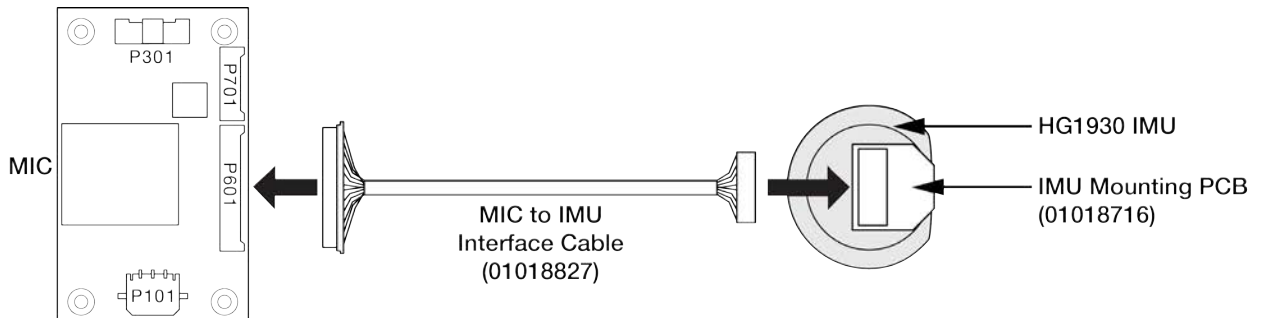
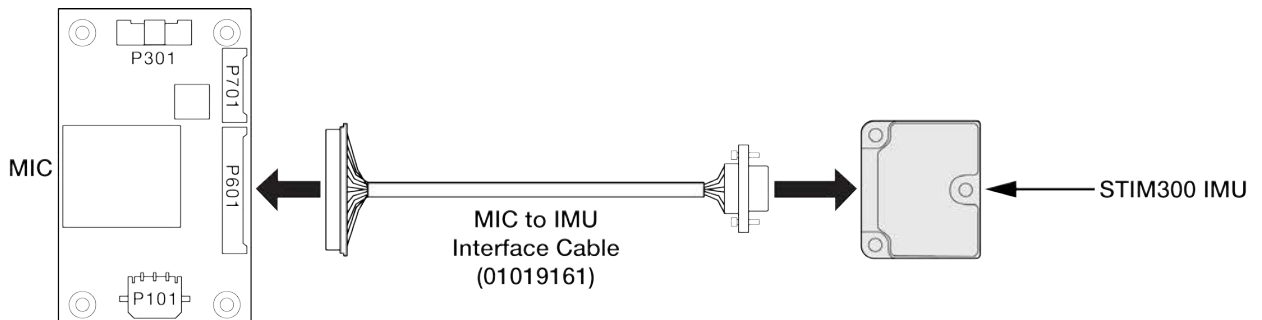


Figure 7: Connect the STIM300 IMU to the MIC (OEM Cable Kit: 01019174)



Connect Power to the MIC

Connect a +10 to +30 V DC power supply to the power connector (P101) on the MIC. See *MIC Connectors* on page 187 for pinout information for the power connector.



This connection provides power to the MIC and the OEM719.

Connect the Input and Output Signals

All of the communication connections to the MIC and the OEM719 receiver are available on the communications connector (P601) on the MIC. These connections include:

- MIC serial port
- OEM615 serial port (COM2)

- USB port
- Event1 trigger input
- Event2 trigger input
- 1 PPS (Pulse Per Second) output
- VARF (Variable Frequency) output
- Reset input
- Position Valid output

See *MIC Connectors* on page 187 for the pinouts of the communications connector.



All signal I/O with the exception of the USB port are at LVTTTL levels. To connect the MIC to devices that use other signals levels, such as a computer with an RS-232 serial port, an interface circuit that converts LVTTTL to the other signal level must be used.



Use a twisted pair for the USB port connection and keep the wires as short as possible.

2.3.2 Install a MIC in a Standalone Configuration

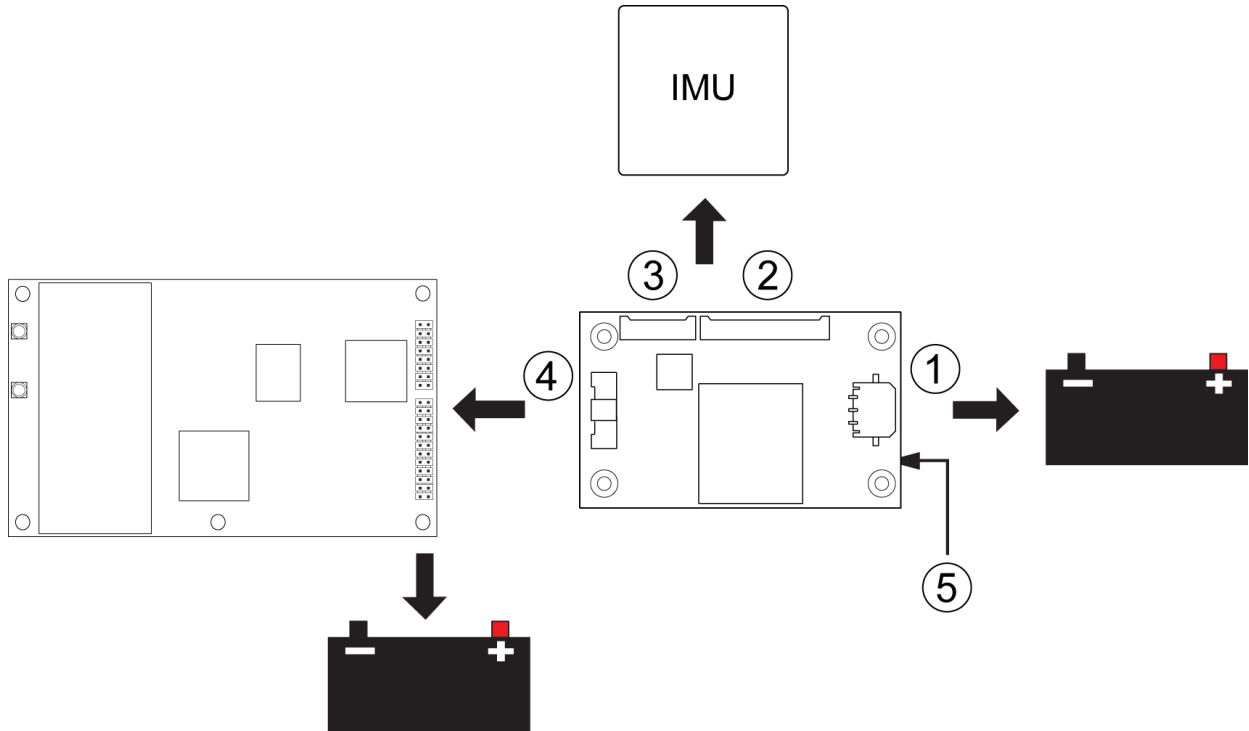
In a standalone configuration, the MIC is mounted separately from the OEM7 receiver.



Important! Assemble in accordance with applicable industry standards. Ensure all Electrostatic Discharge (ESD) measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the MIC, receiver and IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces and the IMU.

For more information about ESD practices, see the OEM7 Installation and Operation User Manual (OM-20000168).

Figure 8: Basic MIC Set Up



Ref	Connector	Part Number	Mating Connector	Description
1	P101	43650-0313 (Molex)	43645-0300 (Molex)	Connects to the MIC power supply. (user supplied cable)
2	P601	53780-2070 (Molex)	51146-2000 (Molex)	Connects to HG1700, HG1900, HG1930 and STIM300 IMUs. (NovAtel supplied cable)
3	P701	53780-1070 (Molex)	51146-1000 (Molex)	Connects to ADIS-16488 IMUs. (NovAtel supplied cable)
4	P301	501571-3007 (Molex)	501189-3010 (Molex)	Connects the MIC serial port to the OEM7 receiver. (user supplied cable)
5	J301	ASP-163577-01 (Samtec)	N/A	This connector is not used.



For information about the MIC connectors and pin-outs, see *MIC Connectors* on page 187.



For information about the OEM7 receiver card connectors and pinouts, refer to the OEM7 Installation and Operation User Manual (OM-20000168).



OEM729 Recommendations

- Use COM1 for connection to a computer. COM1 uses RS-232 levels and can be connected to a computer without additional interface circuitry.
- Use COM2 for connection to the MIC serial port. Both the MIC serial port and COM2 use LVCMOS levels and can be connected without additional interface circuitry.

Use the following steps to install the OEM7 receiver and MIC:

1. Mount the components of the SPAN system. See *Mount the SPAN System Components* below.
2. Connect the IMU to the MIC. See *Connect the IMU to the MIC* below.
3. Connect the MIC to the OEM7 receiver. See *Connect the MIC to a Receiver* on page 32.
4. Connect power to the MIC and OEM7 receiver. See *Connect Power to the MIC and OEM7 Receiver* on page 33.

Mount the SPAN System Components

1. Mount the antenna. See *Mounting the GNSS Antenna* on page 18.
2. Mount OEM7 receiver. See the OEM7 Installation and Operation User Manual (OM-20000168) for information about installing an OEM7 receiver.
3. Install the MIC in a secure enclosure to reduce environmental exposure and RF interference. If there is sufficient space, the MIC can reside in the same enclosure as the receiver.

Use the screws supplied with the MIC card to secure the MIC to its mounting location. See *MIC Mechanical Drawings* on page 185 for the MIC dimensions.



Ensure the MIC is mounted close enough to the IMU so the interface cable can reach both devices.



Ensure all standoffs are properly installed and the mounting location is flat. The amount of board deflection (bow and twist) must not exceed 0.75%. For example, on the MIC which is 75 mm long and 46 mm wide, the deflection along the length must not exceed 0.56 mm and the deflection along the width must not exceed 0.34 mm.

4. Mount the IMU. See *Mount the IMU* on page 19.

Connect the IMU to the MIC

1. Attach the IMU mounting Printed Circuit Board (PCB) to the IMU. Ensure all the pins on the header are aligned with the holes on the mating connector.



An IMU mounting PCB is not used with the STIM300 IMU.

2. Mount the IMU. See *Mount the IMU* on page 19.
3. Connect the IMU-to-MIC interface cable to the IMU.
4. Connect the IMU-to-MIC interface cable to the IMU connector on the MIC.
 - Use the 10 pin locking connector (P701) for the ADIS IMUs.
See *Figure 9: Connect the ADIS IMU to the MIC (OEM Cable Kit: 01019007)* below.
 - Use the 20 pin locking connector (P601) for the HG1700, HG1900, HG1930 or STIM300 IMU.
See *Figure 10: Connect the HG1700 IMU to the MIC (OEM Cable Kit: 01018868)* below, *Figure 11: Connect the HG1900 IMU to the MIC (OEM Cable Kit: 01018871)* on the next page, *Figure 12: Connect the HG1930 IMU to the MIC (OEM Cable Kit: 01018869)* on the next page or *Figure 13: Connect the STIM300 IMU to the MIC (OEM Cable Kit: 01019174)* on the next page.

Figure 9: Connect the ADIS IMU to the MIC (OEM Cable Kit: 01019007)

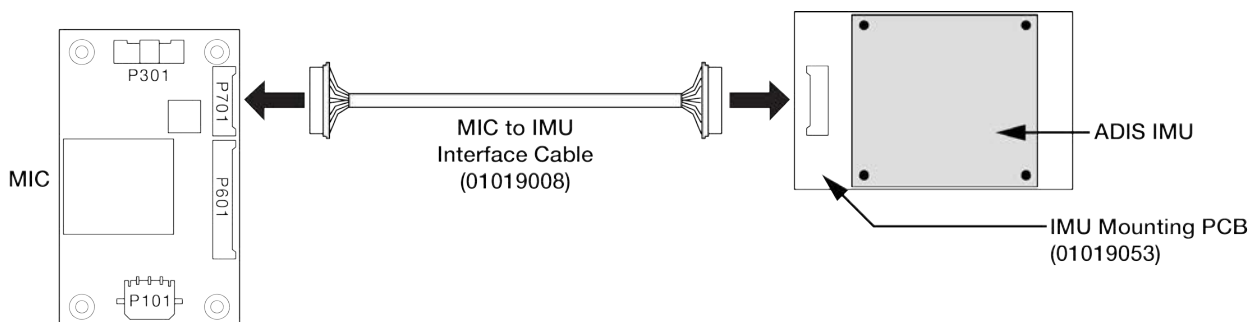


Figure 10: Connect the HG1700 IMU to the MIC (OEM Cable Kit: 01018868)

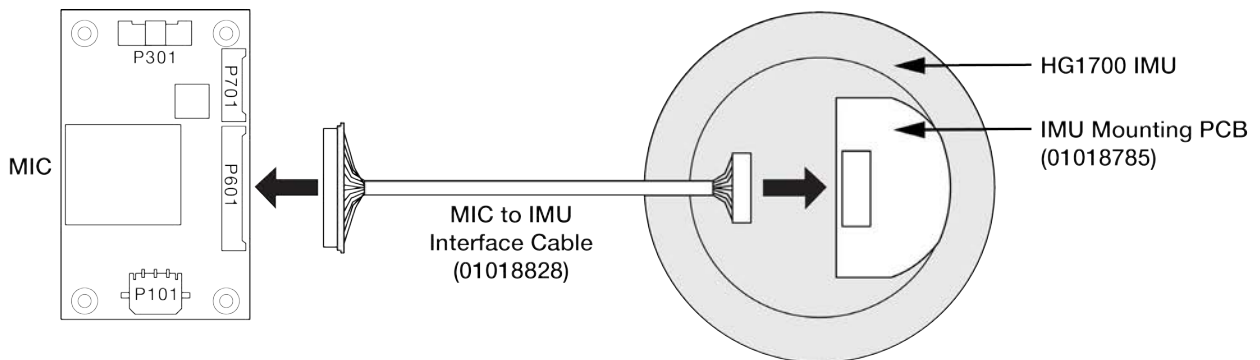


Figure 11: Connect the HG1900 IMU to the MIC (OEM Cable Kit: 01018871)

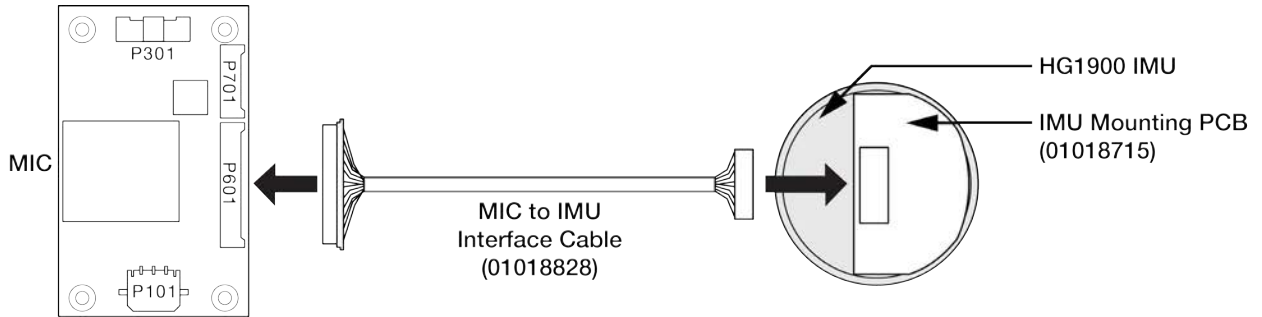


Figure 12: Connect the HG1930 IMU to the MIC (OEM Cable Kit: 01018869)

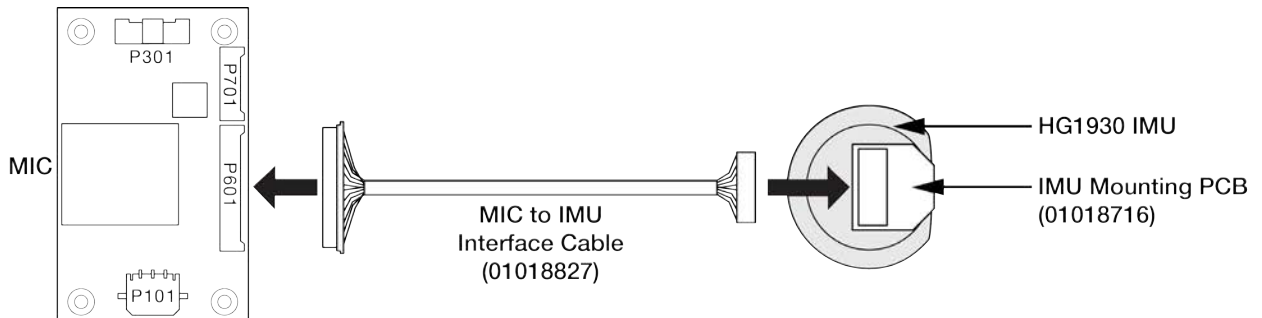
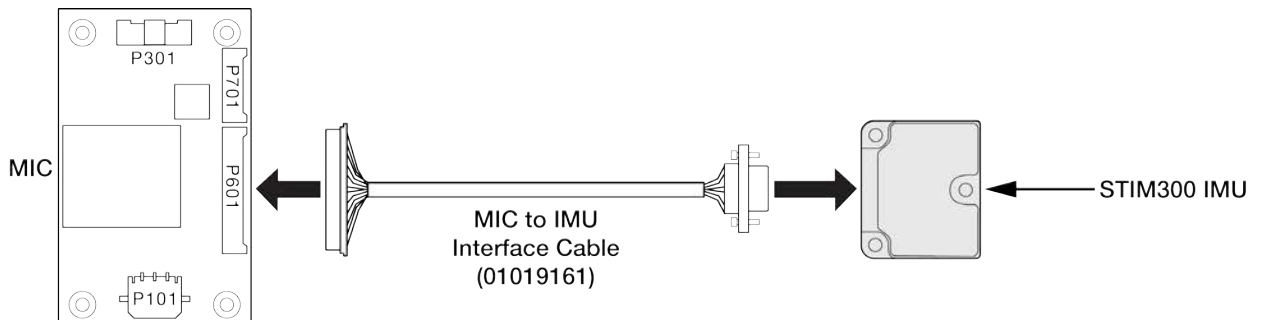


Figure 13: Connect the STIM300 IMU to the MIC (OEM Cable Kit: 01019174)



Connect the MIC to a Receiver

1. Using a customer supplied wiring harness, connect the MIC serial port to a serial port on the OEM7 receiver. The MIC serial port is available on the communications connector (P301) of the MIC.

See *MIC Connectors* on page 187 for the pinouts of the communications connector. See the OEM7 Installation and Operation User Manual (OM-20000168) for information about connecting a serial port to the receiver.

See *UIC Connectors* on page 199 for pinout information for the communications connector (J102).



All signal I/O on the MIC, with the exception of the USB port, are at LVCMOS levels.

To connect the MIC to devices that use other signals levels, such as a computer with an RS-232 serial port, an interface circuit that converts LVCMOS to the other signal level must be used.

Table 3: COM Port Recommendations

OEM719 OEM7700	All of the COM ports on these receivers use LVCMOS levels and are signal level compatible with the MIC serial port.
OEM729	Use COM2 or COM3 of the OEM729 receiver to connect the MIC serial port. These COM ports use LVCMOS levels and are signal level compatible with the MIC serial port. COM1 on the OEM729 receiver can use RS-232 levels (default) or RS-422 levels and is not signal level compatible with the MIC serial port.



For information about the OEM7 receiver card connectors and pinouts, refer to the OEM7 Installation and Operation User Manual (OM-20000168).

2. Connect a computer (for monitoring and configuration) to the OEM7 receiver. Refer to the OEM7 Installation and Operation User Manual (OM-20000168) for information about connecting data communications equipment to an OEM7 receiver.

Connect Power to the MIC and OEM7 Receiver



A separate power supply is required for the OEM7 family receiver. For information about the power supply requirements, refer to the Technical Specifications appendix for the receiver card in the OEM7 Installation and Operation User Manual (OM-20000168).

1. Using a customer supplied wiring harness, connect a +10 to +30 V DC power supply to the power connector (P101) on the MIC.
See *MIC Connectors* on page 187 for pinout information for the power connector.
2. Using a customer supplied wiring harness, connect power to the OEM7 receiver. See the OEM7 Installation and Operation User Manual (OM-20000168) for information about connecting power to the receiver.

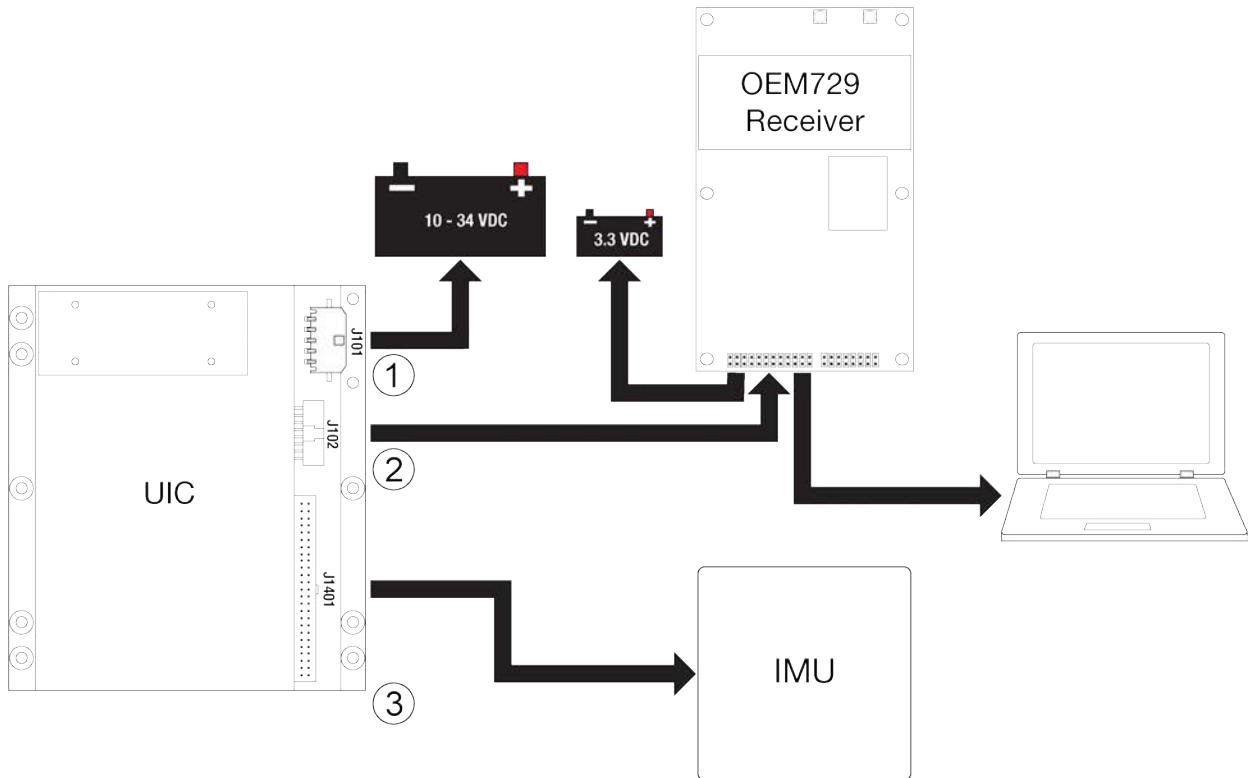
2.4 UIC Set Up

For IMUs that are not mounted inside a NovAtel IMU enclosure (e.g. OEM-IMU-ISA-100C), an interface card is required to connect an IMU to an OEM7 receiver. The Universal IMU Controller (UIC) provides the connection between OEM7 receiver cards and IMUs.



IMUs have different interface requirements. Use a UIC to connect OEM IMUs (ISA-100C, LN200, HG-1900 or μ IMU) to an OEM7 receiver. Use a MEMS Interface Card (MIC) to connect MEMS OEM IMUs (ADIS-16488, HG-1700, HG-1900, HG-1930 or STIM-300) to an OEM7 receiver. See *MIC Set Up* on page 22.

Figure 14: Basic UIC Set Up



Ref	Connector	Part Number	Mating Connector	Description
1	J101	43650-0513 (Molex)	43645-0500 (Molex)	Connects to the UIC power supply. (user supplied cable)
2	J102	98464-G61-16LF (FCI)	90311-016LF (FCI)	Connects the UIC serial port to the OEM7 receiver (user supplied cable)
3	J1401	LTMM-125-02-L-D (Samtec)	SQT-125-01-L-D (Samtec)	Connects to the IMU. (NovAtel supplied cable)



For information about the UIC connectors and pinouts, see *UIC Connectors* on page 199.



For information about the OEM7 receiver card connectors and pinouts, refer to the OEM7 Installation and Operation User Manual (OM-20000168).



Important! Assemble in accordance with applicable industry standards. Ensure all Electrostatic Discharge (ESD) measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the UIC, receiver and IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces and the IMU.

For more information about ESD practices, see the OEM7 Installation and Operation User Manual (OM-20000168).

Use the following steps to install the OEM7 receiver and UIC:

1. Mount the components of the SPAN system. See *Mount the SPAN System Components* below.
2. Connect the IMU to the UIC. See *Connect the IMU to the UIC* on the next page.
3. Connect the UIC to the OEM7 receiver. See *Connect the UIC to a receiver* on the next page.
4. Connect power to the UIC and OEM7 receiver. See *Connect Power to the UIC and OEM7 Receiver* on page 37.

2.4.1 Mount the SPAN System Components

1. Mount the antenna. See *Mounting the GNSS Antenna* on page 18.
2. Mount OEM7 receiver. See the OEM7 Installation and Operation User Manual (OM-20000168) for information about installing an OEM7 receiver.
3. Mount the IMU. See *Mount the IMU* on page 19.
4. Install the UIC in a secure enclosure to reduce environmental exposure and RF interference. If there is sufficient space, the UIC can reside in the same enclosure as the receiver.

Use M3 pan head stainless steel screws to secure the UIC to its mounting location. See *UIC Mechanical Drawings* on page 197 for the UIC dimensions.



Ensure the UIC is mounted close enough to the IMU so the interface cable can reach both devices. For the length of the interface cable, refer to the specifications for the IMU in *IMU Technical Specifications* on page 83.



Ensure the mounting location provides at least 5 mm of clearance below the board to allow for components on the bottom of the UIC.



Ensure all standoffs are properly installed and the mounting location is flat. The amount of board deflection (bow and twist) must not exceed 0.75%. For example, on the UIC which is 100 mm long and 113 mm wide, the deflection

along the length must not exceed 0.75 mm and the deflection along the width must not exceed 0.85 mm.

2.4.2 Connect the IMU to the UIC

1. If using an ISA-100C, attach the screw kit to the *IMU to UIC Interface Cable*.
2. Connect the *IMU to UIC Interface Cable* supplied with the UIC to the IMU. For IMU cables with screws, secure the cable to the IMU using the screws.
3. Connect the *IMU to UIC Interface Cable* to the IMU connector (J1401) on the UIC.

2.4.3 Connect the UIC to a receiver

1. Using a customer supplied wiring harness, connect the UIC serial port to a serial port on the OEM7 receiver. See *UIC Connectors* on page 199 for pinout information for the communications connector (J102).



The serial port on the UIC uses RS-422 levels.

To connect the UIC to devices that use other signals levels, such as an LVCMOS COM port on the GNSS receiver, an interface circuit that converts to and from RS-422 must be used.

Table 4: COM Port Recommendations

OEM719	All of the COM ports on these receivers use LVCMOS levels.
OEM7700	An interface circuit that converts to and from RS-422 levels is required for the port connected to the UIC.
OEM729	COM1 on the OEM729 receiver can use RS-232 levels (default) or RS-422 levels. To use COM1 for connection to the UIC, configure the COM1 port to use RS-422 levels. Refer to the OEM7 Installation and Operation User Manual (OM-20000168) for information about changing COM1 to RS-422 levels. COM2 and COM3 on the OEM729 receiver use LVCMOS levels. To use COM2 or COM3 for connection to the UIC serial port, an interface circuit that converts to and from RS-422 levels is required.



For information about the OEM7 receiver card connectors and pinouts, refer to the OEM7 Installation and Operation User Manual (OM-20000168).

2. Connect a computer (for monitoring and configuration) to the OEM7 receiver. Refer to the OEM7 Installation and Operation User Manual (OM-20000168) for information about connecting data communications equipment to an OEM7 receiver.

2.4.4 Connect Power to the UIC and OEM7 Receiver



A separate power supply is required for the OEM7 family receiver. For information about the power supply requirements, refer to the Technical Specifications appendix for the receiver card in the OEM7 Installation and Operation User Manual (OM-20000168).

1. Using a customer supplied wiring harness, connect a +10 to +34 V DC power supply to the power connector (J101) on the UIC.
See *UIC Connectors* on page 199 for pinout information for the power connector.
2. Using a customer supplied wiring harness, connect power to the OEM7 receiver. See the OEM7 Installation and Operation User Manual (OM-20000168) for information about connecting power to the receiver.

2.4.5 UIC Status LEDs

The LEDs on the UIC provide basic status information.

Figure 15: UIC Status LEDs

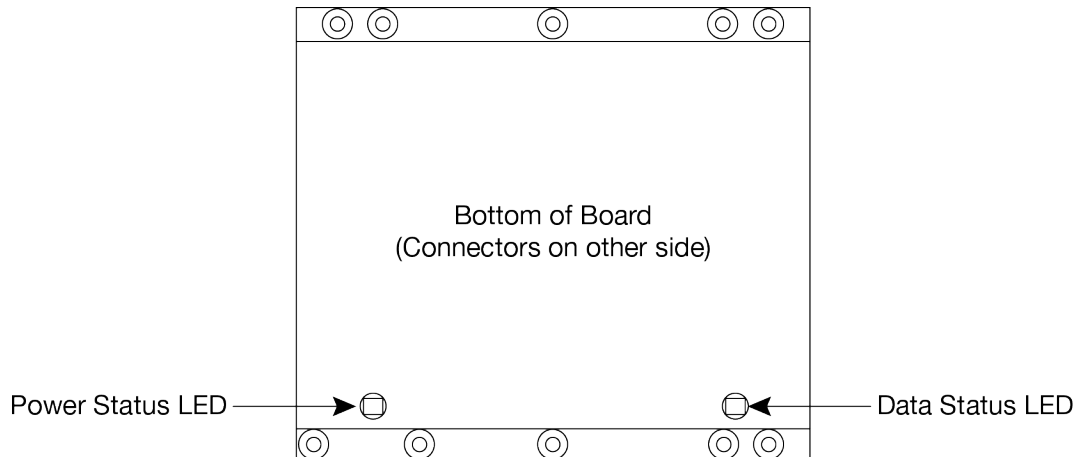


Table 5: UIC Status LEDs

LED	Off	On (Red)	On (Green)	Flash Slow (Yellow, 1 Hz)	Flash Fast (Yellow, 3 Hz)
Power	No power to UIC.	An error occurred during boot up or initialization.	UIC is powered on with no errors detected during boot up or initialization.	Boot up and IMU initialization.	N/A

LED	Off	On (Red)	On (Green)	Flash Slow (Yellow, 1 Hz)	Flash Fast (Yellow, 3 Hz)
Data	No communication between UIC and GNSS receiver.	N/A	UIC is transmitting and receiving data without errors.	UIC is receiving data from the receiver, but not transmitting data.	UIC is transmitting data to the receiver, but not receiving data.


2.5 IMU LEDs

The IMU-IGM and IMU Enclosure (IMU-HG1900, IMU-ISA-100C, IMU-LN200, IMU- μ IMU) have LEDs that provide the IMUs basic status information.


Table 6: IMU-IGM LEDs

LED	Off	On	Flash Slow (1 Hz)	Flash Fast (3 Hz)
Power (Red)	No power to unit	Unit is powered on	UNKNOWN or UNSUPPORTED IMU	Programming error
GNSS ¹ (Green)	Waiting for GPS time	Time Status FINE or FINESTEERING	Time status COARSE, COARSESTEERING or FREEWHEELING	N/A
INS ¹ (Green)	Not connected to IMU	Connected to IMU	N/A	Bootup or loading firmware

Table 7: IMU Enclosure LEDs

LED	Off	On (Red)	On (Green)	Flash Slow (Yellow, 1 Hz)	Flash Fast (Yellow, 3 Hz)
Power 	No power to IMU Enclosure.	An error occurred during boot up or initialization.	IMU Enclosure is powered on with no errors detected during boot up or initialization.	Boot up and IMU initialization.	N/A

¹The IMU-IGM must be connected to a GNSS receiver before the state of these LEDs can change to On.

LED	Off	On (Red)	On (Green)	Flash Slow (Yellow, 1 Hz)	Flash Fast (Yellow, 3 Hz)
COM 	No communication between IMU Enclosure and GNSS receiver.	N/A	IMU Enclosure is transmitting and receiving data without errors.	IMU Enclosure is receiving data from the receiver, but not transmitting data.	IMU Enclosure is transmitting data to the receiver, but not receiving data.

Chapter 3 SPAN Operation

Before operating your SPAN system, ensure that you have followed the installation and setup instructions in *SPAN Installation* on page 18.

You can use the NovAtel Connect software to configure receiver settings and to monitor data in real-time, between a rover SPAN system and base station.

SPAN system output is compatible with post-processing software from the NovAtel Waypoint Products Group. Visit our web site at www.novatel.com for details.



Ensure the Control Panel Power Settings on your computer are not set to go into Hibernate or Standby modes. Data will be lost if one of these modes occurs during a logging session.

3.1 Definition of Reference Frames Within SPAN

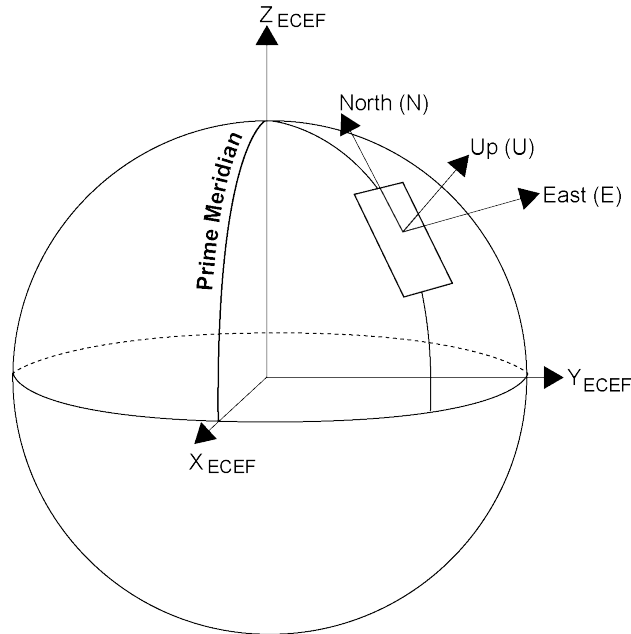
The reference frames that are most frequently used throughout the SPAN documentation are the following:

- *The Local-Level Frame (ENU)* below
- *The IMU Body Frame* on the next page
- *The Vehicle Frame* on the next page
- *The User Output Frame* on page 42

3.1.1 *The Local-Level Frame (ENU)*

The definition of the local level coordinate frame is as follows:

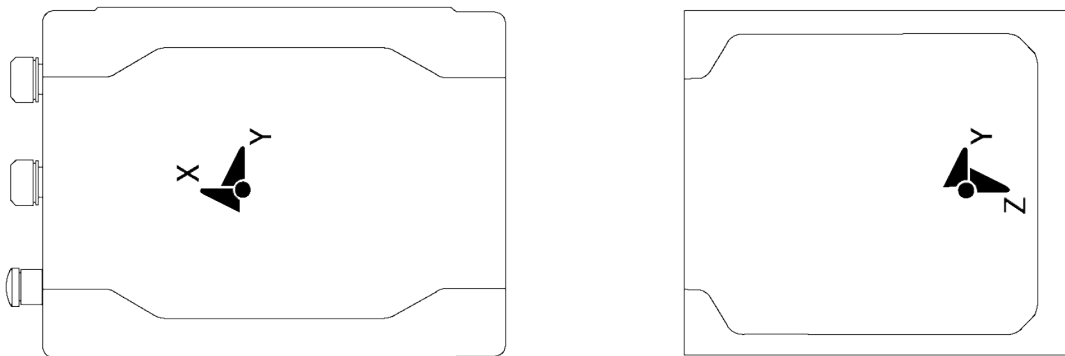
- z-axis – pointing up (aligned with gravity)
- y-axis – pointing north
- x-axis – pointing east

Figure 16: Local-Level Frame (ENU)

3.1.2 The IMU Body Frame

The definition of the IMU Body frame is given by the physical axes of the IMU and represents how the sensors are mounted inside the IMU. If your IMU is enclosed, both the IMU Body frame axes and center of navigation are marked on the enclosure. Otherwise, refer to *IMU Technical Specifications* on page 83 for illustrations of the IMU Body frame axes for each IMU.

The origin of this frame is not the enclosure center, but the center of navigation (sensor center).

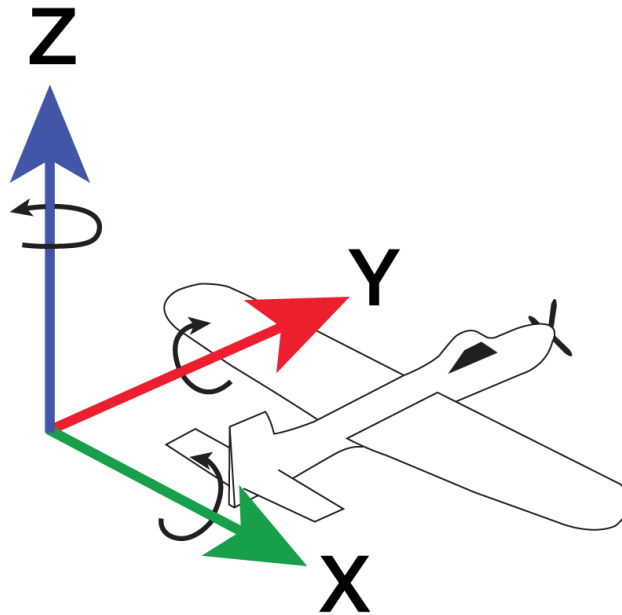
Figure 17: IMU Body Frame Marking

3.1.3 The Vehicle Frame

The definition of the vehicle frame is as follows:

- z-axis – points up through the roof of the vehicle perpendicular to the ground
- y-axis – points out the front of the vehicle in the direction of travel
- x-axis – completes the right-handed system (out the right-hand side of the vehicle when facing forward)

Figure 18: Vehicle Frame



3.1.4 The User Output Frame

The user output frame is an arbitrary frame, which can be optionally defined to transfer inertial output to a more useful position or reference frame.

By default, SPAN position and velocity output is given at the center of navigation of the IMU. To output position and velocity at a different location, specify a user offset translation using the **SETINSTRLANSATION** command.

By default, SPAN attitude output is the rotation from the Local-Level frame to the Vehicle frame. If attitude output is desired relative to another frame, specify a user offset rotation using the **SETINSROTATION** command.

3.2 SPAN Translations and Rotations

A SPAN system combines GNSS and INS into a single system. In a GNSS system, the position is reported relative to the phase center of the GNSS antenna. In an INS system, the velocity and attitude data is reported relative to the center of navigation of the IMU. For a SPAN system to provide a combined GNSS+INS position, velocity and attitude, it must know where the GNSS antenna is positioned relative to the IMU.

The orientation of the IMU relative to the forward direction of the vehicle is also needed to convert the velocity and attitude changes sensed by the IMU into the actual motion of the vehicle.

If the SPAN system incorporates other devices, such as a camera connected to an Event Input, the SPAN system also needs to know the location and orientation of these additional devices relative to the IMU.

3.2.1 Translational Offsets

The three dimensional distances between the IMU and other SPAN components are called translational offsets.

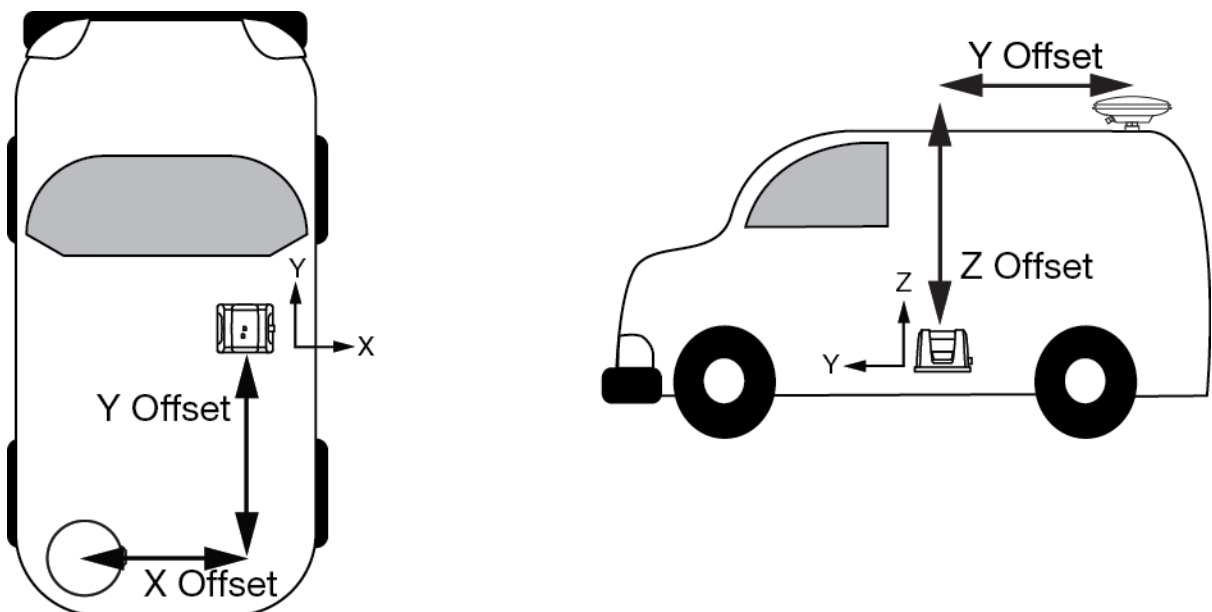
The translational offsets are measured in three directions, X axis, Y axis and Z axis, typically relative to the IMU Body frame. Translational offsets can also be entered relative to the Vehicle frame.



The X, Y and Z axes of the IMU Body frame are typically indicated on the IMU enclosure. The X, Y and Z axes of the IMU Body frame are also indicated on the mechanical drawings of the IMUs in the *IMU Technical Specifications* on page 83.

Figure 19: IMU to Antenna Translation Offset below shows an example of the translational offsets from the IMU to a GNSS antenna. In this example, the IMU Body Frame (indicated by the small arrows) has the Y axis pointing in the direction of the vehicle motion and the z axis pointing up.

Figure 19: IMU to Antenna Translation Offset



If the distances measured in this example were X Offset = 1 m, Y Offset = 1.5 m and Z Offset = 2 m, the following values would be entered, based on the IMU Body Frame:

- x = -1
- y = -1.5
- z = 2

The translational offsets are entered using the **SETINSTRLATION** command. For this example, the command to enter these offsets is:

```
SETINSTRLATION ANT1 -1 -1.5 2
```



The measurements for the translational offsets should be done as accurately as possible, preferably to within millimeters especially for RTK operation. Any error in the offsets will translate into an error in the INS position.

The translational offsets from the IMU to the GNSS antenna are required for all SPAN systems. However, some SPAN systems may have other sensors or devices integrated into the system for which the SPAN needs translational offsets. For example, a gimbal mount or a camera or LiDAR connected to an Event Input line. The offsets to these additional sensors and devices are also entered using the **SETINSTRANSLATION** command.

By default, the translational offsets are entered in the IMU Body Frame. However, in some systems the IMU Body Frame may not be known precisely. For these cases, the **SETINSTRANSLATION** command has an option that allows the offsets to be entered relative to the Vehicle Frame. In these cases, the rotation from the IMU Body Frame to the Vehicle Frame (RBV) is used to rotate offsets into the default IMU Body frame as required. To achieve the best results, this means that the RBV rotation must be known very precisely. Typically this is achieved through the SPAN RBV Calibration procedure. See *Body to Vehicle Frame Rotation Calibration Routine* on page 61 for information about this calibration procedure.

3.2.2 Rotational Offsets

The differences in orientation between the IMU and other SPAN components are called rotational offsets. Rotational offsets are given as the rotation from the IMU Body Frame to the frame of interest.

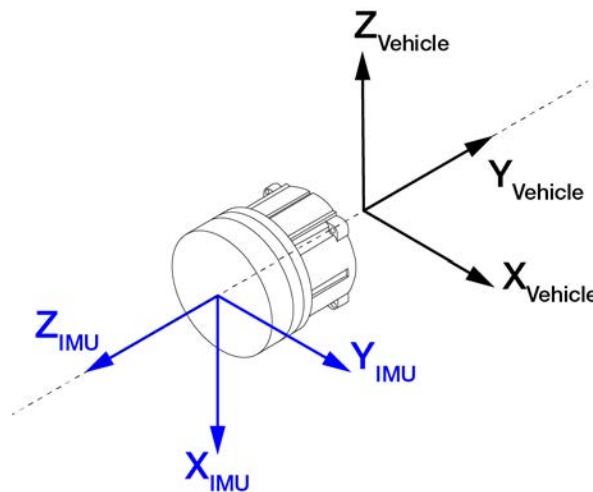


The order of rotations is Z-X-Y and all rotations are right handed.

Generally, frames of reference are defined as Z up, with Y forward, and X completing the right-handed system. An example is the vehicle frame, where Z is always considered to be upwards, Y forward through the direction of travel, and X to the right.

Rotational Offsets - Example

Consider an IMU installed in the following way:



Here, the Euler Angles to rotate from the IMU Body frame to the Vehicle frame (RBV) are:

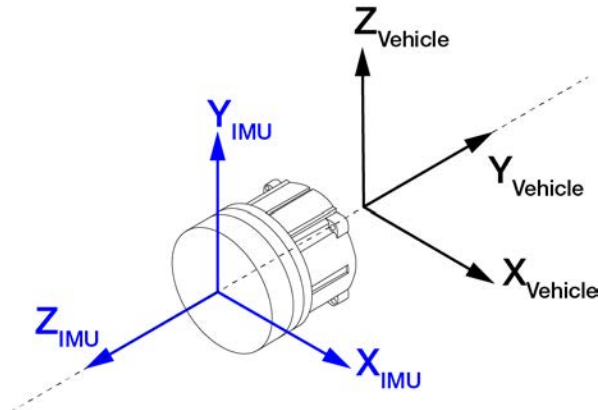
- X: -90
- Y: 0
- Z: +90

To reach this answer, keep in mind the following rules:

- The goal is to rotate the IMU Body frame to be coincident with the Vehicle frame (i.e. IMU X equals Vehicle X, IMU Y equals Vehicle Y, IMU Z equals Vehicle Z).
- You must rotate from the IMU Body frame to the Vehicle frame.
- You must rotate in the order Z, X, Y.
- Positive rotation is defined according to the right hand rule.

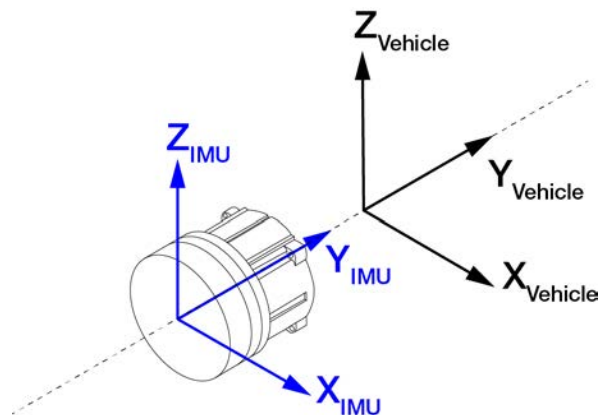
Z Rotation:

Observe that if a positive 90 degree rotation is performed about the IMU Z axis, the rotated IMU X axis becomes collinear with the Vehicle X axis.



X Rotation:

Observe that if a negative 90 degree rotation is performed about the new IMU X axis, the rotated IMU Y axis is now collinear with the Vehicle Y axis, and the rotated IMU Z axis is also collinear with the Vehicle Z axis.



Y Rotation:

Since all three sets of axes are already collinear, our frames are coincident, and no further rotation is required.



This solution is not unique. Due to the properties of Euler Angles, there are usually multiple sets of equivalent rotations.

The rotational offsets are entered using the **SETINSROTATION** command. For this example, the command to enter the rotations for the previous example is:

```
SETINSROTATION RBV -90 0 90
```

3.3 Communicating with the SPAN System

Install the NovAtel PC Utilities (NovAtel Connect and Convert) on the computer you intend to use to configure and monitor the SPAN system. (Alternatively, you can use a terminal emulator program such as HyperTerminal to communicate with the receiver.)



To access and download the most current version of the NovAtel Connect PC Utilities, go to the NovAtel website at www.novatel.com/support/search/items/PC%20Software.

Refer to the NovAtel Connect Help file for more details on NovAtel Connect. The Help file is accessed by choosing *Help* from the main menu in NovAtel Connect.

This procedure describes communicating with the SPAN system using a serial or USB connection. For information about communicating with the SPAN system using an Ethernet connection, see the OEM7 Installation and Operation User Manual (OM-20000168).

To enable communication from your computer to the SPAN system using NovAtel Connect:

1. Launch NovAtel Connect from the **Start** menu folder specified during the installation process. The default location is Start | Programs | NovAtel Connect | NovAtel Connect.
2. To define a new connection, select **New Connection** from the **Device** menu. The New Connection window appears. If a connection is already defined for the SPAN system, choose **Open Connection** and skip to step 9.
3. Enter a name for the connection.
4. Select **Serial** or **USB** from the **Type** drop down list.
5. Select the computer port that the SPAN enabled OEM7 receiver is connected to from the **Port** drop down list.
6. If you selected **Serial**, select the highest baud rate supported by your computer from the **Baud Rate** drop down list. OEM7 receivers support up to 460800.
7. If you selected **Serial**, clear the **Use hardware handshaking** check box.
8. Click the **OK** button to save the new device settings.
9. Select the SPAN receiver from the Available Device Connections area of the Open Connection window.
10. Click the **Open** button to open SPAN receiver communications.
11. As NovAtel Connect establishes the communication session with the receiver, a progress box is displayed.
12. Select Tools | Logging Control Window from the NovAtel Connect main menu to control the receiver's logging to files and serial ports. Refer to the NovAtel Connect on-line Help for more information.

13. Use the Console window to enter commands. See *Data Collection for Post Processing* on page 69.



If you want to save your receiver's configuration to NVM, ensure that all windows, other than the Console window, are closed in NovAtel Connect and then use the **SAVECONFIG** command.

3.3.1 INS Window in NovAtel Connect

NovAtel Connect provides a graphical user interface to allow you to monitor the operation of the SPAN system.

The INS Window in NovAtel Connect is described below. Refer to the NovAtel Connect help file for more details on NovAtel Connect.

INS Window: The Position, Velocity and Attitude (roll, pitch and azimuth) sections display data from the INSPVA log along with standard deviations calculated from the **INSSTDEV** log. Information in the ZUPT (Zero Velocity Update) section reflects the current INSZUPT command setting. The receiver uses the X, Y and Z Offset fields to specify an offset from the IMU, for the output position and velocity of the INS solution, as specified by the **SETINSTRANSULATION USER** and **SETINSROTATION USER** commands or the NovAtel Connect SPAN wizard. The *INS Configuration/Status* section displays the IMU type, IMU Status and local date/time information. The dial is a graphical display of the Roll, Pitch and Azimuth values indicated by an arrow on each axis.

3.4 Software Configuration

On a SPAN system, both the GNSS receiver and the IMU must be configured.

3.4.1 Minimum Recommended Configuration

When configuring your OEM7 SPAN system for first time use, the following is the minimum amount of information required to ensure proper operation of a SPAN system.

Required Information	Required Command
IMU type and communication port	CONNECTIMU
IMU to primary antenna lever arm	SETINSTRANSULATION ANT1
IMU to vehicle frame rotation	SETINSROTATION RBV

While this is the minimum amount of information required, additional information is typically needed for SPAN systems. The following commands are commonly used to configure SPAN systems.

Common User Settings	Appropriate Command	Notes
IMU to output position offset	SETINSTRANSULATION USER	Default output position is at the IMU center

Common User Settings	Appropriate Command	Notes
IMU to output frame rotation	SETINSROTATION USER	Default output frame is the vehicle frame
IMU to secondary antenna lever arm	SETINSTRANSFORMATION ANT2	Only required for dual antenna systems
Vehicle type	SETINSPROFILE	
Minimum alignment velocity	SETALIGNMENTVEL	

3.4.2 GNSS Configuration

The GNSS configuration can be set up for different accuracy levels such as single point, SBAS, DGPS, PPP and RTK. Refer to the OEM7 Installation and Operation User Manual (OM-20000168) for details on DGPS, RTK, L-Band or SBAS setup and operation.

With no additional configuration, the system operates in single point mode.

3.4.3 INS Profiles

INS Profiles are a method to improve the performance of the system in different conditions. Different constraining approaches can be applied to the solution depending on what type motion is expected during operation. The greatest improvements are currently available in fixed-axle land vehicles in a method often referred to as dead reckoning. Ships and helicopter type vehicles are harder to improve as these vehicles can move more freely in lateral or vertical directions.



The LAND profile is currently the only released profile option. The other profiles make small changes to default settings and are available for testing.

Table 8: INS Profiles

Profile	Description	Default Settings Modified
LAND	Intended for fixed-axle land vehicles. Enables non-holonomic constraints for vehicle motion.	Enable Dead Reckoning Enable direction detection on kinematic alignment routine Enable course over ground attitude updates
MARINE	Intended for boats	Disable Zero Velocity Updates Disable turn-on bias estimation Enable Heave algorithms
FIXEDWING	Intended for fixed wing aircraft	Disables Zero Velocity Updates
VTOL	Intended for Vertical Take Off and Landing aircraft (helicopter, quadcopter, etc.)	Disable Zero Velocity Updates
RAIL	Intended for railway applications	Retains Default configuration

Use

To use an INS Profile, send the **SETINSPROFILE** command at startup (or save to NVM) to activate the mode. For example:

```
SETINSPROFILE LAND
```



The currently selected profile option is available in the **INSCONFIG** log.

RBV Calibration

For the profiles to provide the greatest benefit, the rotation offset of the IMU body to the vehicle frame (RBV) should be known as accurately as possible. Since constraints happen at the vehicle level, any error in the offset will translate into worse performance. These parameters are estimated in the background when the system is fully converged, however it is always better to have this measured as precisely as possible before mission critical data is collected.

The INSCALIBRATE RBV functionality can be used to estimate and save these offsets to NVM in a controlled manor.

3.4.4 SPAN Configuration

Configure SPAN Manually

Follow these steps to enable INS as part of the SPAN system using software commands or see *SPAN Configuration with NovAtel Connect* on page 52 for the alternate method using the NovAtel Connect software utility:



A GNSS antenna with a clear view of the sky must be connected and tracking satellites for operation.

1. Issue the **CONNECTIMU** command to specify the type of IMU being used and the receiver port connected to the IMU, see *Table 9: Enable INS Commands* below and the **CONNECTIMU** command.

Table 9: Enable INS Commands

IMU Type	CONNECTIMU command
ADIS-16488	CONNECTIMU COMx ADIS16488
HG1700 AG11	CONNECTIMU COMx HG1700_AG11
HG1700 AG17	CONNECTIMU COMx HG1700_AG17

¹Use the COM port number the IMU is connected to.

If you are using the OEM719+MIC board stack, you must use COM1.

For SPAN systems with a OEM729 receiver, COM2 is the recommended serial port for the IMU, however you can use any available port for these IMUs

IMU Type	CONNECTIMU command
HG1700 AG58	CONNECTIMU COMx HG1700_AG58
HG1700 AG62	CONNECTIMU COMx HG1700_AG62
HG1900 CA50	CONNECTIMU COMx HG1900_CA50
HG1930 CA50	CONNECTIMU COMx HG1930_CA50
IMU-FSAS	CONNECTIMU COMx IMAR_FSAS
IMU-CPT	CONNECTIMU COMx KVH_COTS
IMU-IGM-A1	CONNECTIMU COMx ADIS16488
IMU-IGM-S1	CONNECTIMU COMx STIM300
IMU-ISA-100C	CONNECTIMU COMx ISA100C
IMU-KVH1725	CONNECTIMU COMx KVH_1725
IMU-KVH1750	CONNECTIMU COMx KVH_1750
IMU- μ IMU	CONNECTIMU COMx LITEF_MICROIMU
LN-200	CONNECTIMU COMx LN200
STIM300	CONNECTIMU COMx STIM300
G320	CONNECTIMU SPI EPSON_G320

- If the SPAN system uses an OEM-HG1900 IMU connected to a MIC card, issue the following command.

```
SETIMUPORTPROTOCOL RS232
```

Basic configuration of the SPAN system is now complete. The inertial filter starts after the GNSS solution is solved and the IMU is connected.

- Issue the **SETINSTRANSULATION** command, using the **ANT1** parameter, to enter the distance from the IMU to the GNSS antenna. See the **SETINSTRANSULATION** command in the OEM7 Commands and Logs Reference Manual (OM-20000169) for more information.

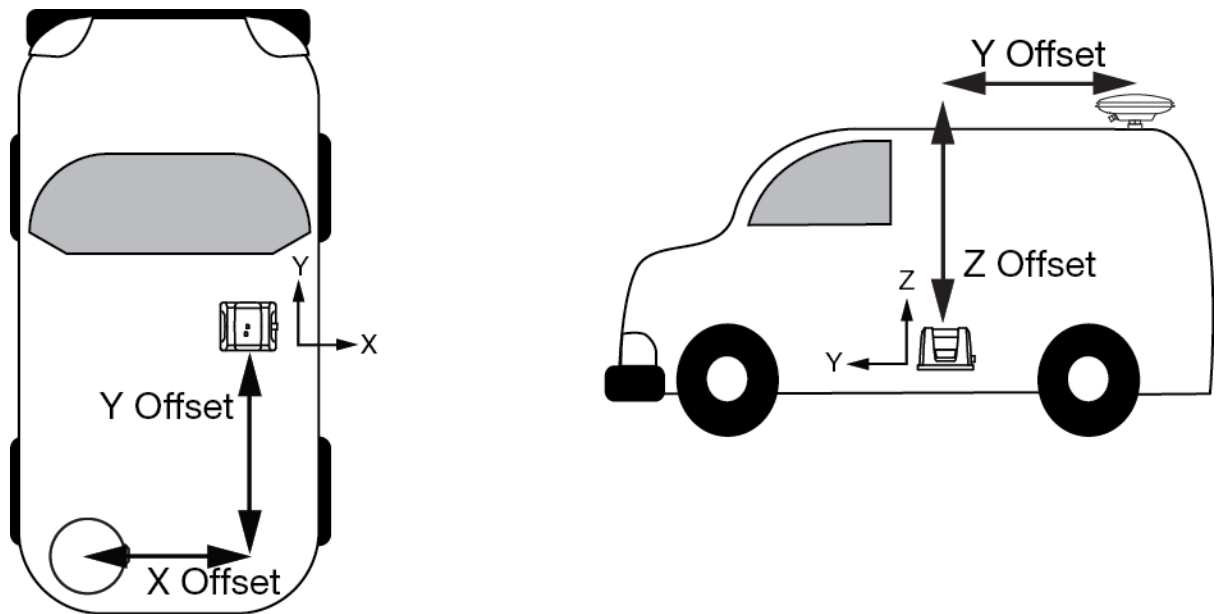
The offset between the antenna phase center and the IMU axis must remain constant and be known accurately (m). The X, Y and Z directions are clearly marked on the IMU enclosure. The SETINSTRANSULATION parameters are (where the standard deviation fields are optional and the distances are measured from the IMU to the antenna):

```
ANT1 x_offset y_offset z_offset [x_stdev] [y_stdev] [z_stdev]
```

¹Use the COM port number the IMU is connected to.

If you are using the OEM719+MIC board stack, you must use COM1.

For SPAN systems with a OEM729 receiver, COM2 is the recommended serial port for the IMU, however you can use any available port for these IMUs



This example shows a mounting configuration with a negative X offset, negative Y offset and positive Z offset.

A typical RTK GNSS solution is accurate to a few centimetres. For the integrated GNSS+INS system to have this level of accuracy, the offset must be measured to within a centimetre. Any offset error between the two systems shows up directly in the output position. For example, a 10 cm error in recording this offset will result in at least a 10 cm error in the output.

If it is impossible to measure the IMU to GNSS antenna offset precisely, the offset can be estimated by carrying out the Lever Arm Calibration Routine. See *Lever Arm Calibration Routine* on page 60.

- Issue the **SETINSROTATION** command, using the **RBV** parameter, to enter the Euler Angle rotation from the IMU Body frame to the Vehicle frame. See the **SETINSROTATION** command in the OEM7 Commands and Logs Reference Manual (OM-20000169) for more information.

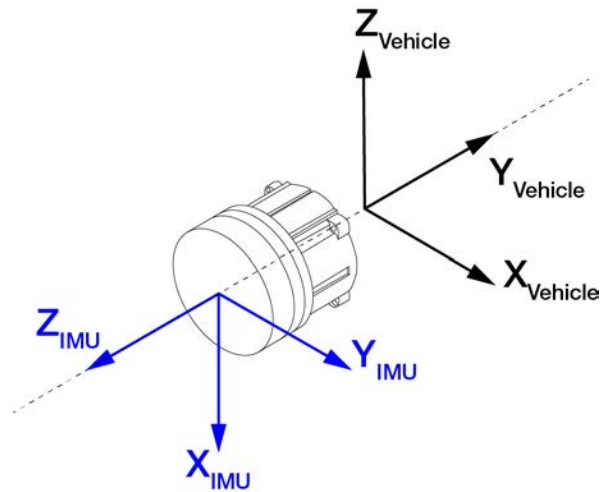
Accurate knowledge of the rotational offset between the IMU Body frame and the Vehicle frame (the RBV rotation) is critical to correctly computing an attitude solution, and is required before a Kinematic alignment is possible.

The SETINSROTATION parameters are (where the standard deviation fields are optional):

```
RBV x_rotation y_rotation z_rotation [x_stddev] [y_stddev] [z_stddev]
```



The order of rotations is Z-X-Y. All rotations are right handed.



For an example of how to solve for the IMU Body to Vehicle frame rotation refer to *Rotational Offsets* on page 44.

If the rotation between the IMU Body frame and the Vehicle frame is not precisely known, enter an approximate rotation (to the nearest 45 degrees). The precise offset can be estimated by carrying out the *Body to Vehicle Frame Rotation Calibration Routine* on page 61.

SPAN Configuration with NovAtel Connect

Follow these steps to enable INS as part of the SPAN system using the NovAtel Connect software utility:



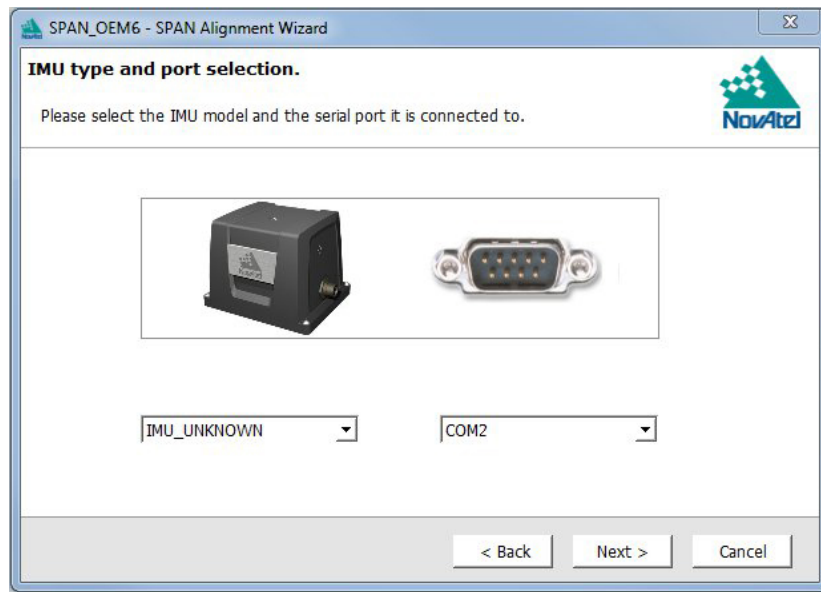
The NovAtel Connect screen shots shown may differ from your version of NovAtel Connect.



Download the latest NovAtel Connect PC Utilities suite of software and documentation, including NovAtel Connect™ from www.novatel.com/support/info/documents/809.

1. **SPAN basic configuration:** Select Wizards | SPAN Alignment from the NovAtel Connect toolbar. This wizard takes you through the steps to complete a coarse or kinematic alignment, select the type of IMU and configure the receiver port connected to the IMU to accept

IMU data:



3.5 Real-Time Operation

SPAN operates through the OEM7 command and log interface. Commands and logs are documented in the OEM7 Commands and Logs Reference Manual (OM-20000169).

Real-time operation notes:

- By default, raw IMU data will begin to output as soon as the IMU is connected. However an initial position is required to begin the INS alignment process. This position is typically set by GNSS. The GNSS position will not be used until the FINESTEERING time status is reached. This requires a GNSS antenna connected with a clear view of the sky. See *System Start-Up and Alignment Techniques* on the next page for more details.
- The inertial solution is computed separately from the GNSS solution. The GNSS solution is available from the SPAN system through the GNSS-specific logs, even without SPAN running. The integrated GNSS+INS solution is available through special INS logs documented in the OEM7 Commands and Logs Reference Manual (OM-20000169).
- The IMU raw data is available at the maximum rate of output of the IMU. Because of this high data rate, a shorter header format was created. These shorter header logs are defined with an S (RAWIMUSXB rather than RAWIMUXB). We recommend you use these logs instead of the standard header logs to save throughput on the COM port.

Status of the inertial solution can be monitored using the inertial status field in the INS logs, see *Table 10: Inertial Solution Status* below.

Table 10: Inertial Solution Status

Binary	ASCII	Description
0	INS_INACTIVE	IMU logs are present, but the alignment routine has not started; INS is inactive.

Binary	ASCII	Description
1	INS_ALIGNING	INS is in alignment mode.
2	INS_HIGH_VARIANCE	The INS solution is still being computed but the azimuth solution uncertainty has exceeded the threshold. The default threshold is IMU dependent. ^a The solution is still valid but you should monitor the solution uncertainty in the INSTDEV log. You may encounter this state during times when the GNSS, used to aid the INS, is absent. ^b
3	INS_SOLUTION_GOOD	The INS filter is in navigation mode and the INS solution is good.
6	INS_SOLUTION_FREE	The INS filter is in navigation mode and the GNSS solution is suspected to be in error. This may be due to multipath or limited satellite visibility. The inertial filter has rejected the GNSS position and is waiting for the solution quality to improve.
7	INS_ALIGNMENT_COMPLETE	The INS filter is in navigation mode, but not enough vehicle dynamics have been experienced for the system to be within specifications.
8	DETERMINING_ORIENTATION	INS is determining the IMU axis aligned with gravity.
9	WAITING_INITIALPOS	The INS filter has determined the IMU orientation and is awaiting an initial position estimate to begin the alignment process.
10	WAITING_AZIMUTH	The INS filter has determined the IMU orientation, received an initial position and completed initial bias estimates. Azimuth input (from vehicle motion, dual antenna or command) is required for alignment.
11	INITIALIZING_BIASES	The INS filter has determined the IMU orientation, received an initial position and is conducting an initial IMU bias estimate.
12	MOTION_DETECT	Vehicle motion has been detected.

3.5.1 System Start-Up and Alignment Techniques

The system requires an initial position, velocity and attitude estimate to start the navigation filter. This is called system alignment. On start-up the system has no position, velocity or attitude information. When the system is first powered up, the following sequence of events happens:

1. The first satellites are tracked and coarse time is solved.
2. Enough satellites are tracked to compute a position.

^aThis value is configured using the INSTTHRESHOLDS command. See the OEM7 Commands and Logs Reference Manual (OM-20000169) for more information..

^bSee also question #7 in *Frequently Asked Questions* on page 238.

3. Receiver “fine time” is solved, meaning the time on board the receiver is accurate enough to begin timing IMU measurements.
4. The INS Status field changes from INS_INACTIVE through DETERMINING_ORIENTATION and WAITING_INITIALPOS.
5. Once a GNSS position is available, an initial IMU bias estimate is conducted. During this period, the INS Status field reports INITIALIZING_BIASES.
6. After the bias estimate is complete, the coarse alignment routine starts. Bias estimates will be refined and a static alignment completed, if IMU quality allows. During this period the INS Status field reports INS_ALIGNING.
7. If static coarse alignment is not possible or is locked out by command, the system will require an external azimuth input, either from vehicle motion, dual antenna input or command input. While in this state the INS Status field reports WAITING_AZIMUTH.
If vehicle movement is detected, any ongoing static coarse alignment will be reset, and the INS Status field will report MOTION_DETECT.
8. After an alignment is completed, the INS Status field changes to INS_ALIGNMENT_COMPLETE. The system transitions to navigation mode.
9. The solution is refined using updates from GNSS. Once the system is operating within specifications and after some vehicle movement, the INS Status field changes to INS_SOLUTION_GOOD. This indicates that the estimated azimuth standard deviation is below the preset value. If it increases above the preset value, the status changes to INS_HIGH_VARIANCE.

Coarse Alignment

The coarse alignment is the default alignment routine for SPAN. The alignment starts automatically when a GNSS solution is available, the receiver has computed fine time, the IMU is connected and configured and initial bias estimates have been completed. During the coarse alignment, accelerometer and gyro measurements are averaged over a period of time to measure Earth rotation and gravity. From these averaged measurements, initial estimates of roll, pitch and heading are computed. Because the coarse alignment uses averaged sensor output, the vehicle must remain stationary for the duration of the alignment, which is approximately 45 seconds. The attitude estimates solved by the alignment are larger than the system specified attitude accuracy and vary upon the characteristics of the sensor and the geographic latitude of the system. Attitude accuracy converges with motion after the coarse alignment is complete (see *Navigation Mode* on page 58).



The ADIS-16488, IMU-CPT, IMU-IGM, HG1930, G320 and STIM300 IMUs cannot perform coarse alignments, as these IMUs cannot accurately measure Earth rotation. For these IMUs, the default alignment routine is the kinematic alignment. Refer to *Kinematic Alignment* below. If a stationary alignment is required, refer to *Manual Alignment* on the next page.

Kinematic Alignment

An alternate form of aligning the SPAN system is a kinematic alignment. A kinematic alignment can be used for any SPAN system and is the best alignment alternative for lower performance sensors (ADIS-16488, IMU-IGM, IMU-CPT, HG1930, G320 and STIM300). The kinematic or

moving alignment is performed by estimating the heading from the GNSS velocity vector and injecting it into the SPAN filter as the initial system heading.

This method for alignment assumes that the roll and pitch of the vehicle are near to zero. This should be kept in mind when attempting to do this in airborne or marine environments as these assumptions may not hold causing a poor initial solution.

For the kinematic alignment routine to work optimally, the course-over-ground azimuth and pitch must match the IMU enclosure azimuth and pitch. (For example, a plane being blown in the wind has a large 'crab angle' and the course-over ground trajectory will not match the direction the IMU is pointing.)

The rotation from the IMU Body frame to the Vehicle frame (RBV) must be set to enable kinematic alignment. In order to simplify this configuration it is strongly suggested that you mount the IMU in parallel to the vehicle frame. The Y axis marked on the IMU enclosure, should point in the direction of travel.

The kinematic alignment begins when the receiver has a good GNSS position, fine time is solved, the Body to Vehicle frame rotation is known and a GNSS velocity of at least 5 m/s (~ 18 km/h) is observed. During kinematic alignment, keep the vehicle roll at less than 10° .



5 m/s is the default alignment velocity. If a different alignment velocity is required, it can be changed using the **SETALIGNMENTVEL** command. See the OEM7 Commands and Logs Reference Manual (OM-20000169) for more information.

While it is possible to lower the minimum speed required for kinematic alignment to take place, the higher the value, the more closely the course-over-ground estimate will match the vehicle heading.

The accuracy of the initial attitude of the system following the kinematic alignment varies and depends on the dynamics of the vehicle. The attitude accuracy will converge to within specifications once some motion is observed by the system. This transition can be observed by monitoring the INS Status field in the INS logs.

Dual Antenna Alignment

SPAN can also use heading information available from a NovAtel Dual Antenna ALIGN solution to rapidly perform an alignment. Refer to *SPAN with Dual Antenna* on page 79 for details.

NVM Seeded Alignment

SPAN can use the alignment information from a previous power up to quickly perform an alignment. For information about enabling and using an NVM Seeded Alignment, refer to *INS Seed / Fast INS Initialization* on the next page.

Manual Alignment

If the initial attitude (roll, pitch, azimuth) of the IMU is known, it can be entered manually using the **SETINITAZIMUTH** command. Refer the OEM7 Commands and Logs Reference Manual (OM-20000169)(OM-20000xxx) for more information about the **SETINITAZIMUTH** command.



A manual alignment should be used only if the attitude is accurately known.

3.5.2 INS Seed / Fast INS Initialization

The INS Seed functionality is an alignment method whereby INS alignment information from a previous powerup can be injected into the system at startup to achieve an INS alignment very quickly. This is especially useful for systems that previously required a kinematic alignment.

This works by automatically saving the current INS position and attitude information to NVM when the system is stationary. During subsequent power ups, the saved solution is compared to the current position of the system, and if it is determined not to have moved since the seed data was stored, this information is used to rapidly initialize the INS filter, meaning the system will be ready for navigation.

This feature is enabled via the **INSSEED** command. This command setting must be saved to NVM via the **SAVECONFIG** command to be used upon next system boot-up.

Criteria

For the INS seed functionality to be enabled, the **INSEED ENABLE** command must be sent.

Saving

The following criteria must be met for a valid seed to be saved into receiver NVM.

- The INS solution status must be `INS_SOLUTION_GOOD`.
- The velocity drops below 0.2 m/s.

When these conditions are met, the requirement information is automatically saved to NVM. If these conditions cease to be met, the saved information is automatically discarded.

Use at Boot-up

Upon boot, several checks are done to verify that any seed data existing in NVM is appropriate for use. These checks require a GNSS position to be computed, so an NVM seed will never be injected prior to achieving a GNSS position. The following criteria must be met in order to use a seed:

- Seed data from NVM must be valid
- The system must be stationary
- The system must not have moved significantly from the seed position: <10 metres position and 5 degrees in roll and pitch



INJECT Option (Advanced Users Only)

There is an advanced option available to skip the second and third validation steps described in the boot-up section above. This can be used if GNSS is not available on power-up or if speed to achieve an alignment is imperative.

This option is for advanced users only. Forcing an injection of an NVM seed without the validation checks can cause an unstable INS solution if the vehicle has moved.

Apart from injecting the seed at startup without validation, this will also remove some requirements typically asserted to allow the filter to converge. This will allow the system to run without GNSS adequately at startup.

Example Usage

Enabling functionality after FRESET:

1. Send the following command.

```
INSSEED ENABLE VALIDATE
```

2. Send the following command.

```
SAVECONFIG
```

Saving valid INS information:

1. Drive around until INS Status = INS_SOLUTION_GOOD.
2. Bring the system to a complete stop before powering off or resetting.

Using valid INS information on start-up:

1. Remain static while starting.
2. Wait for system to receive valid position from GNSS.
3. If validated, INS information will be injected.

System Indicators

The Extended Solution Status field has bits that indicate the Alignment type that occurred and NVM seed status.

Alignment Type: Bits 26-28

These bits indicate how the INS system reached INS_ALIGNMENT_COMPLETE. When the INS system aligns using saved INS solution data from NVM, bits 27-29 will be set to 101

NVM Seed Status: Bits 29-31

These bits indicate the current status of the seeding process at start-up, as described in the table below:

Table 11: NVM Seed Indication

Bit 29-31 Values	Hex Value	NVM Seed Type
000	0x00	NVM Seed Inactive
001	0x01	Seed stored in NVM is invalid
010	0x02	NVM Seed failed validation check
011	0x03	NVM Seed is pending validation (awaiting GNSS)
100	0x04	NVM Seed Injected

3.5.3 Navigation Mode

Once the alignment routine has successfully completed, SPAN enters navigation mode.

SPAN computes the solution by accumulating velocity and rotation increments from the IMU to generate position, velocity and attitude. SPAN models system errors by using a filter. The GNSS solution, phase observations and automatic zero velocity updates (ZUPTs) provide updates to

the filter. Peripheral updates can also be supplied; wheel sensor for displacement updates or an external receiver for heading updates.

Following the alignment, the attitude is coarsely defined, especially in heading. Vehicle dynamics, specifically turns, stops and starts, allow the system to observe the heading error and allows the heading accuracy to converge. The amount of dynamics required for filter convergence vary by the alignment quality, IMU quality, and maneuvers performed. The INS Status field changes to `INS_SOLUTION_GOOD` once convergence is complete. If the attitude accuracy decreases, the INS Status field changes to `INS_HIGH_VARIANCE`. When the accuracy converges again, the INS status continues as `INS_SOLUTION_GOOD`.

3.5.4 Data Collection

The INS solution is available in the INS-specific logs with either a standard or short header. Other parameters are available in the logs shown in *Table 12: Solution Parameters* below:

Table 12: Solution Parameters

Parameter	Logs	
Position	INSPOS or INSPOSS INSPVA or INSPVAS	INSPOSX or INSPVAX
Velocity	INSVEL or INSVELS INSSPD or INSSPDS INSPVA or INSPVAS	INSVELX or INSPVAX
Attitude	INSATT or INSATTS INSPVA or INSPVAS	INSATTX or INSPVAX
Solution Uncertainty	INSSTDEV or INSSTDEVS	



The **INSATTX** log, **INSPOSX** log, **INSPVAX** log and **INSVELX** log contain solution and variance information and are therefore large logs. Use a low logging rate (<20 Hz) only. These logs also contain solution uncertainty in standard deviation format.

Note that the position, velocity and attitude are available together in the **INSPVA** log, **INSPVAS** log and **INSPVAX** log.

The inertial solution is available up to a rate of 200 Hz. Data can be requested at a specific synchronous time interval, asynchronously matching the IMU output rate, or can be triggered by the mark input trigger at rates up to 200 Hz.

The GNSS-only solution is still available through the GNSS-only logs such as `RTKPOS` and `PSRPOS`. When running SPAN, rates of non-INS logs should be limited to a maximum rate of 5 Hz. Refer to the OEM7 Commands and Logs Reference Manual (OM-20000169) for more details on these logs. INS-only data logging and output can be at rates of up to the rate of the IMU data.



The highest rate that you should request GNSS logs (RANGE, BESTPOS, RTKPOS, PSRPOS, and so on) while in INS operation is 5 Hz. If the receiver is not running INS (no IMU is attached), GNSS logs can be requested at rates up to 20 Hz.



Ensure that all windows, other than the Console, are closed in NovAtel Connect and then use the **SAVECONFIG** command to save settings in NVM. Otherwise, unnecessary data logging occurs and may overload your system.



Logging Restriction Important Notice

Logging excessive amounts of high rate data can overload the system. When configuring the output for SPAN, NovAtel recommends that only one high rate (>50 Hz) message be configured for output at a time. It is possible to log more than one message at high rates, but doing so could have negative impacts on the system. Also, if logging 100/200 Hz data, always use the binary format and, if possible, the short header binary format (available on most INS logs).

For optimal performance, log only one high rate output at a time. These logs could be:

- Raw data for post processing
RAWIMUXSB ONNEW (output rate depends on IMU see *Table 1: SPAN-Compatible IMU Models* on page 15)
 - RAWIMU logs are not valid with the ONTIME trigger. The raw IMU observations contained in these logs are sequential changes in velocity and rotation. As such, you can only use them for navigation if they are logged at their full rate. See details of these logs in the OEM7 Commands and Logs Reference Manual (OM-20000169).
- Real time INS solution
IMURATEPVA ONNEW or IMURATEPVAS ONNEW
(These logs require asynchronous logging to be enabled. See **ASYNCHINSLOGGING** command in the OEM7 Commands and Logs Reference Manual (OM-20000169))
 - Other possible INS solution logs available at high rates are: INSPVASB, INSPOSSB, INSVELSB, INSATTSB

Specific logs need to be collected for post-processing. See *Data Collection for Post Processing* on page 69.

To store data from an OEM7 receiver, connect the receiver to a computer running NovAtel Connect or other terminal program capable of recording data.

3.5.5 Lever Arm Calibration Routine

Each time the system is re-mounted on a vehicle, or the IMU or antenna is moved on the vehicle, the lever arm must be redefined either through manual measurement or through calibration.



We recommend that you measure the lever arm using survey methodology and equipment, for example, a total station. Only use calibrations when precise measurement of the lever arm is not possible.

Initial estimates and uncertainties for the lever arm may be entered using the **SETINSTRANSLATION ANT1** command. The calibration routine uses these values as the starting point for the lever arm computation.



The Lever Arm Calibration routine is not available for the IMU-CPT, HG-1930, ADIS-16488, G320, IMU-IGM or STIM300.

The steps involved in the calibration are:

1. Apply power to the receiver and the IMU.
2. Configure the SPAN system, see *SPAN Configuration* on page 49.
3. Perform an initial system alignment using one of the methods described in *System Start-Up and Alignment Techniques* on page 54. Ensure the system reaches Solution Good.
4. Enter the initial estimate for the lever arm using the **SETINSTRANSLATION ANT1** command.

Ensure the standard deviation values entered for the antenna offset are not overly optimistic (i.e, err on the side of a larger standard deviation).

5. Enable calibration using the **INSCALIBRATE** command with an optional standard deviation target.

```
INSCALIBRATE ANT1 NEW [target_stdev]
```

6. To monitor the calibration, log **INSCALSTATUS** using the ONCHANGED trigger.
7. Start to move the system. The lever arm is not observable while the system is stationary. Immediately, drive a series of maneuvers such as figure eights. The turns should alternate between directions, and you should make an equal number of turns in each direction. Some height variation in the route is also useful for providing observability in the Z-axis.
8. When the calibration is complete, either because the accuracy requirement has been met, or the calibration been halted by user command, the calibrated offset value can be viewed in either the **INSCALSTATUS** log or the **INSCONFIG** log.

To save a calibrated lever arm for subsequent start ups, issue the **SAVECONFIG** command after calibration is complete. If the IMU or GNSS antenna are re-mounted, re-run the calibration routine to compute an accurate lever arm.



For information about the logs and commands used in this procedure, refer to the OEM7 Commands and Logs Reference Manual (OM-20000169).

3.5.6 Body to Vehicle Frame Rotation Calibration Routine

Kinematic alignment requires that the rotational offset between the vehicle and IMU Body frame (RBV) is known. If the angles are simple (that is, a simple rotation about one axis) the values can easily be entered manually through the **SETINSROTATION RBV** command. If the rotational

offset is more complex (that is, rotation is about 2 or 3 axis), then the calibration routine provides a more accurate estimation of the values.

The steps for the calibration routine are:

1. Apply power to the receiver and IMU.
2. Configure the SPAN system including an approximate the IMU Body to Vehicle frame (RBV) rotation. See *SPAN Configuration* on page 49.
3. Ensure that an accurate lever arm has been entered into the system either manually or through a lever arm calibration, see *Lever Arm Calibration Routine* on page 60.
4. Perform an initial system alignment using one of the methods described in *System Start-Up and Alignment Techniques* on page 54. Ensure the system reaches Solution Good.
5. Enable calibration using the **INSCALIBRATE** command with an optional standard deviation target.

```
INSCALIBRATE RBV NEW [target_stddev]
```

6. To monitor the calibration, log **INSCALSTATUS** using the ONCHANGED trigger.
7. Start to move the system. As with the lever arm calibration, movement of the system is required for the observation of the angular offsets.

Drive a straight course on level ground (remember that most roads have a crown resulting in a constant roll of a few degrees). Avoid driving on a surface with a constant, non-zero, slope to prevent biases in the computed angles. Vehicle speed must be greater than 5 m/s (18 km/hr) for the calibration to complete.

8. When the calibration is complete, either because the accuracy requirement has been met, or the calibration been halted by user command, the calibrated offset value can be viewed in either the **INSCALSTATUS** log or the **INSCONFIG** log.

To save a calibrated rotation for subsequent start ups, issue the **SAVECONFIG** command after calibration is complete. Each time the IMU is re-mounted this calibration should be performed again. See also *Coarse Alignment* on page 55 and *Kinematic Alignment* on page 55 for details on coarse and kinematic alignment.



After the **INSCALIBRATE RBV ENABLE** command is entered, there are no body-vehicle rotation parameters present and a kinematic alignment is NOT possible. Therefore this command should only be entered after the system has performed either a static or kinematic alignment and has a valid INS solution.



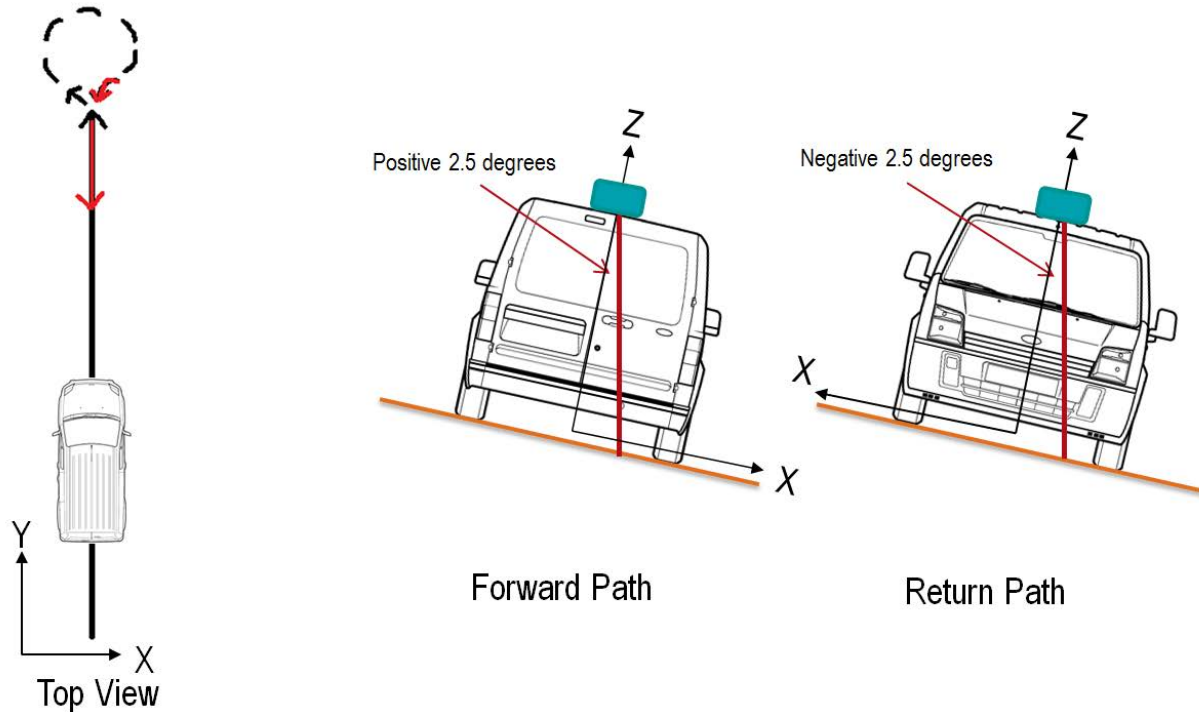
For information about the logs and commands used in this procedure, refer to the OEM7 Commands and Logs Reference Manual (OM-20000169).

3.5.7 Multi-Line Body to Vehicle Frame Rotation Calibration Routine

The single pass Body to Vehicle frame offset calibration feature assumes flat ground when estimating the roll offsets between the IMU Body and Vehicle frames, as this component of the rotational offset is difficult to observe through typical ground vehicle motion. In practice this can result in an outstanding roll offset error as high as several degrees. For applications where vehicle roll must be well known, or pass-to-pass accuracy of a highly offset position is especially

important, the Multi-Line IMU Body to Vehicle frame offset calibration routine offers higher calibrated accuracy in roll. This is done by running independent calibrations over the same ground path in opposite directions; averaging the results cancels out the effect of any terrain induced roll. A minimum of two iterations are required. Additional iteration pairs can be executed for increased reliability.

Figure 20: Multi-Line IMU Body to Vehicle Calibration



The steps for the calibration routine are:

1. Apply power to the receiver and IMU.
2. Configure the SPAN system, see *SPAN Configuration* on page 49.
3. Ensure that an accurate lever arm has been entered into the system either manually or through a lever arm calibration, see *Lever Arm Calibration Routine* on page 60.
4. Perform an initial system alignment using one of the methods described in *System Start-Up and Alignment Techniques* on page 54. Ensure the system reaches Solution Good.
5. Enable a new calibration using the **INSCALIBRATE** command, with the optional standard deviation target omitted:

```
INSCALIBRATE RBV NEW
```

6. Start to move the vehicle. Drive a straight course, at a vehicle speed greater than 5 m/s (18 km/hr). A distance of at approximately 250 metres is recommended.

To monitor the calibration, log **INSCALSTATUS** using the ONCHANGED trigger.

7. When the end of the available distance is reached, stop the vehicle. Halt the ongoing calibration by sending the **INSCALIBRATE** command again:

```
INSCALIBRATE RBV STOP
```

8. At this point **INSCALSTATUS** will report a source status of CALIBRATED. Turn the vehicle around and come to a stop on the finishing point of the previous line.
9. Initiate the second pass of the calibration by issuing the **INSCALIBRATE** command with the **ADD** parameter:

```
INSCALIBRATE RBV ADD
```

10. Drive the vehicle back along the original course, until you reach the starting point for the first pass. Stop the vehicle, and re-issue the **INSCALIBRATE** command, with the **STOP** parameter. **INSCALSTATUS** will again indicate a source status of CALIBRATED.

At this point the multi-line calibration can be considered complete, but more iterations can be repeated until the desired accuracy level is reached.

11. When the calibration is complete, the calibrated offset value can be viewed in either the **INSCALSTATUS** log or the **INSCONFIG** log.

To save a calibrated rotation for subsequent start ups, issue the **SAVECONFIG** command after calibration is complete. Each time the IMU is re-mounted this calibration should be performed again.



After the **INSCALIBRATE RBV ENABLE** command is entered, there are no body-vehicle rotation parameters present and a kinematic alignment is NOT possible. Therefore this command should only be entered after the system has performed either a static or kinematic alignment and has a valid INS solution.



For information about the logs and commands used in this procedure, refer to the OEM7 Commands and Logs Reference Manual (OM-20000169).

3.6 Synchronizing External Equipment

A SPAN system allows you to synchronize with external equipment.

All SPAN receivers accept input pulses (events). Each event signal can be configured for positive or negative polarity. Time, or a solution (position, velocity, attitude), can be generated and output with each input pulse.

3.6.1 Configuring an Input Strobe

SPAN systems have two available input strobes. The input strobes apply an accurate GNSS time to the rising, or falling, edge of an input pulse called an event. For each event, an accurate position, velocity or attitude solution is also available. Each input strobe is usually associated with a separate device, therefore different solution output lever arm offsets can be applied to each strobe.

Each input strobe can be configured using the **EVENTINCONTROL** command for the following parameters:

Polarity:

When polarity is set to positive, events trigger on the rising edge. When polarity is set to negative, events trigger on the falling edge.

Time Bias (t_bias):

A constant time bias in ns can be applied to each event pulse. Typically this is used to account for a transmission delay.

Time Guard (t_guard):

The time guard specifies the minimum number of milliseconds between pulses. This is used to coarsely filter the input pulses.

The time of the input pulses is available from the **MARKTIME**, **MARK2TIME**, **MARK3TIME** and **MARK4TIME** log. The solution synchronous with the event pulses is available from the **MARK1PVA**, **MARK2PVA**, **MARK3PVA** and **MARK4PVA** log. The logs required for input strobes are:

LOG MARK1TIMEB ONNEW

Output time for every pulse received.

LOG MARK1PVAB ONNEW

Output time, position, velocity and attitude for every pulse received at the location specified by the **SETINSTRANSLATION** command and **SETINSROTATION** command.

The above example is for the MARK1 event input. The input signal levels are 3.3 V to 0 V. Signal voltages outside these bounds damage the receiver. The minimum detectable pulse duration must be greater than or equal to 1 microsecond.



For information about the logs and commands used in this procedure, refer to the OEM7 Commands and Logs Reference Manual (OM-20000169).

3.7 Adding Timed Sensor Triggers

Use the EVENT IN and EVENT OUT connections to attach up to three sensor devices to an OEM7 receiver and then trigger the sensors based upon GPS time.

In this context a 'sensor' is any external device. The 'sensor' reference in the receiver is an object consisting of an Event_In and Event_Out pair of system strobes all linked by a sensor identifier.

You can send multiple trigger events marked with a user-specified ID and a GPS time to trigger the sensor. At the requested trigger time, the receiver outputs a user-specified LVCMOS level pulse to the sensor and waits for a response pulse to indicate a sensor measurement (i.e. camera exposure). When this response is received, the SPAN system outputs a log with the inertial position/velocity/attitude and the ID of the event.

3.7.1 Configuring the Hardware

A sensor's trigger input is connected to a valid Event_Out and the sensor's response output is connected to a valid Event_In. Three sensor slots are available for use, but may be limited to less depending on the hardware platform used.

Table 13: Valid Event Inputs and Outputs for Timed Sensor Triggers

Valid Event Outputs	Valid Event Inputs
MARK1	MARK1
MARK2	MARK2
MARK3	MARK3
MARK4	MARK4

3.7.2 Configuring the Software

Sensor objects are defined by using the **SETUPSENSOR** command. This command allows the Event_In and Event_Out lines to be specified as well as some parameters for the outgoing and incoming signals.



After configuring a sensor using the **SETUPSENSOR** command, any other commands that affect the selected event lines will disturb this functionality. For example, if MARK4 Out is selected for a sensor, but later the **EVENTOUTCONTROL** command is sent, the **EVENTOUTCONTROL** command will reconfigure the properties of the MARK4 line.

3.7.3 Using Timed Event Pulses

When sensors have been connected and configured, use the **TIMEDEVENTPULSE** command to queue events on the system. **TIMEDEVENTPULSE** specifies the sensors that are affected, the GPS time for the desired event (in weeks and seconds), and an event ID. You can queue 10 unprocessed events at a time. Any time input specified via this command must occur at least 1 second after the command is entered.

The timing accuracy of the **TIMEDEVENTPULSE** output is 2 milliseconds.

3.7.4 Recording Incoming Sensor Events

After a **TIMEDEVENTPULSE** is sent, the system can be configured to accept an incoming pulse from the sensor in order to produce a time and ID tagged inertial solution associated to that event. This is optional and useful if a sensor provides a measurement TOV pulse. The produced log is a TAGGEDxMARKPVA where the 'x' is the Event_In line associated with that sensor (via the **SETUPSENSOR** command).

For example, if the **SETUPSENSOR** command specifies SENSOR1 to use MARK1 in as the input event then a TAGGEDMARK1PVA log will be produced when any pulses on that line are observed. In this case the TAGGEDMARK1PVA log should be requested ONNEW to capture the data.

3.8 SPAN Wheel Sensor Configuration

A wheel sensor is used to measure the distance traveled by counting the number of revolutions of a ground vehicle wheel. Typical wheel sensor hardware outputs a variable frequency pulse that varies linearly with speed. If the pulses are accumulated and the size of the wheel known, a displacement of the wheel over time can be calculated. The SPAN system takes in a wheel sensor input and applies a displacement update to the GNSS+INS Kalman filter in order to

constrain the position error growth during GNSS outages. SPAN also automatically estimates the size of the wheel to mitigate small changes in the size of the wheel due to hardware changes or environmental conditions.

The wheel sensor ticks are accumulated by the IMU and then passed on to the SPAN receiver.

- For IMUEnclosure users (IMU-HG1900, IMU-ISA-100C, IMU-LN200 or IMU- μ IMU), the wheel sensor is connected to the Wheel Sensor port using the optional Wheel Sensor Cable (60723137) or a custom cable. See *IMU Enclosure Wheel Sensor Cable* on page 125 for information about the Wheel Sensor Cable and the Wheel Sensor port pinout.
- For IMU-FSAS and IMU-CPT users, the wheel sensor is integrated via the IMU and wheel velocity commands are not required. See also *IMU-FSAS Odometer Cabling* on page 102
- For IMU-IGM-A1 and IMU-IGM-S1 users, the wheel sensor can be connected to the AUX port on the enclosure using the Auxiliary Interface Cable (01019015).

3.8.1 Wheel Sensor Data Collected on IMU

Wheel Sensor Update Logic

The SPAN system uses the wheel sensor data passed in and timed through the IMU-CPT, IMU-FSAS, IMU-IGM, IMU-HG1900, IMU-ISA-100C, IMU-LN200 or IMU- μ IMU. This timed data is passed to the GNSS+INS filter to perform the update. The timed data is also available through the TIMEDWHEELDATA log. The **TIMEDWHEELDATA** log can be used for applying wheel sensor updates in post-processing.

The SPAN filter uses sequential TIMEDWHEELDATA logs to compute a distance traveled between update intervals (1Hz). This information can be used to constrain free-inertial drift during times of poor GNSS visibility. The filter also contains a state for modeling the circumference of the wheel as it may change due to hardware changes or environmental conditions.

The modeled wheel circumference is available in the **WHEELSIZE** log. Information on how the wheel sensor updates are being used is available in the **INSUPDATESTATUS** log.

Refer to the OEM7 Commands and Logs Reference Manual (OM-20000169) for information about these logs.

iMAR Wheel Sensor Interface for iIMU-FSAS and IMU-CPT users

If you have the iMAR iMWS (Magnetic Wheel Speed Sensor and Converter), the wheel sensor information is sent to the OEM7 receiver along with the raw IMU data. You can integrate other wheel sensor hardware with the IMU-FSAS. The Kistler Wheel Pulse Transducer CWPTA411 (WPT) is used as an example, see *IMU-FSAS Odometer Cabling* on page 102.

The accumulated wheel sensor counts are available by logging the timed wheel data log with the onnew trigger:

```
LOG TIMEDWHEELDATAB ONNEW
```

Set parameters for your installation using the **SETWHEELPARAMETERS** command. Refer to the OEM7 Commands and Logs Reference Manual (OM-20000169) for information about this command.

Wheel Sensor Interface for IMU-IGM users

IMU-IGM accepts TTL level input pulses from a wheel sensor through the AUX connector. For information about the connections available on the AUX connector, see *IMU-IGM Ports* on

page 113.



The SPAN-IGM Auxiliary Port interface cable (01019015) can be used to connect the wheel sensor inputs to the IMU-IGM. However, when this cable is used with an IMU-IGM, only the wheel sensor inputs are available. The other connectors on this cable do not have connections to the IMU or receiver.

Wheel Sensor Interface for IMU Enclosure Users

On SPAN systems with an IMU in an IMU Enclosure (IMU-ISA-100C, IMU-HG1900, IMU-LN200 or IMU- μ IMU), use the to enable the collection of wheel sensor data.

```
ENCLOSUREWHEELSENSOR ENABLE
```

Refer to the OEM7 Commands and Logs Reference Manual (OM-20000169) for information about this command.

3.9 Azimuth Sources on a SPAN System

The SPAN system use three different methods to calculate the azimuth.

- Course Over Ground
- Inertial Azimuth
- ALIGN Azimuth

3.9.1 Course Over Ground

The course over ground azimuth is determined using the position delta between two position solutions computed by the OEM7 receiver. This is the simplest way to compute an azimuth and is done using either the GNSS solution or the INS solution. This method does not work when the vehicle is stationary as any position difference is due to position error and the computed azimuth is meaningless.

Course over ground azimuth is of greatest advantage in aerial or marine environments where the actual direction of travel may not match the forward axis of the aircraft/boat due to winds or currents. This effect is known as the crab angle. Course over ground azimuth is a great way to compute the offset if another means of computing the vehicle azimuth is available.

Course over ground azimuths are available in several different velocity logs. See *Table 14: Logs with Azimuth Data* on the next page.

3.9.2 Inertial Azimuth

The inertial azimuth computed by the SPAN inertial navigation filter. It uses the sensors in the IMU to compute the azimuth of the IMU (this can be rotated to another reference if desired). For more information, see the **SETINSROTATION** command in the OEM7 Commands and Logs Reference Manual (OM-20000169).

This azimuth is the one provided in the majority of the INS logs available to a SPAN user. See *Table 14: Logs with Azimuth Data* on the next page.

3.9.3 ALIGN Azimuth

On SPAN systems with dual antennas, an azimuth is available from the dual antenna baseline. This is the same azimuth that is used as an update to the SPAN solution. It is noisier than the inertial azimuth and is available at a much lower rate, but will have a stable mean. This azimuth is computed from the master antenna to the rover antenna based on how the antennas are oriented on the vehicle.

There is a specific subset of logs that output this azimuth. See *Table 14: Logs with Azimuth Data* below.

Table 14: Logs with Azimuth Data

Log	Log Format	Azimuth Source
BESTVEL	NovAtel	Course Over Ground From the best system solution which could be either GNSS or INS
GPHDT	NMEA	ALIGN
GPVTG	NMEA	Course Over Ground From the best system solution which could be either GNSS or INS
HEADING2	NovAtel	ALIGN
INSATT / INSATTS / INSATTX	NovAtel	Inertial
INSPVA / INSPVAS / INSPVAX	NovAtel	Inertial
INSSPD	NovAtel	Course Over Ground Computed using the INS solution only
PASHR	NMEA	Inertial

3.10 Data Collection for Post Processing

Some operations, such as aerial measurement systems, do not require real-time information from SPAN. These operations are able to generate the position, velocity or attitude solution post-mission in order to generate a more robust and accurate solution than is possible in real-time.

In order to generate a solution in post-processing, data must be simultaneously collected at a base station and each rover. The following logs must be collected in order to successfully post process data.

From a base:

- RANGECPMB ONTIME 1
- RAWEPHEMB ONCHANGED

- GLOEPHEMERISB ONCHANGED (if using GLONASS)

From a rover:

- RANGECMPB ONTIME 1
- RAWEPHEMB ONCHANGED
- GLOEPHEMERISB ONCHANGED (if using GLONASS)
- RAWIMUSXB ONNEW
- INSCONFIGB ONCHANGED
- HEADING2B ONNEW (if using ALIGN dual antenna solution)

Post processing is performed through the Waypoint Inertial Explorer® software package available from the NovAtel Waypoint Products Group. Visit our Web site at www.novatel.com for details.



The highest rate that you should request GNSS logs (RANGE, BESTPOS, RTKPOS, PSRPOS, and so on) while in INS operation is 5 Hz. If the receiver is not running INS (no IMU is attached), GNSS logs can be requested at rates up to 20 Hz.

3.11 Firmware Updates and Model Upgrades

Firmware updates are firmware releases which include fixes and enhancements to the receiver functionality. Firmware updates are released on the web site as they become available.

Model upgrades enable features on the receiver and may be purchased through NovAtel authorized dealers.

Contact your local NovAtel dealer first for more information. To locate a dealer in your area visit Where to Buy | Dealer Network on the NovAtel web site at www.novatel.com/where-to-buy/-sales-offices/ or contact NovAtel Customer Support directly.

For information about how to install firmware updates or model upgrades, refer to the OEM7 Installation and Operation User Manual (OM-20000168).

3.12 Variable Lever Arm

The variable lever arm concept arose to support applications in which the IMU is no longer rigidly fixed to the vehicle, but rather on a gimbal mount. This creates an issue where the input lever arm offsets to the GNSS antenna are no longer correct, because the IMU can rotate on its mount, while the antenna remains fixed.

The use of the variable lever arm functionality requires that the device to which the IMU is attached be able to send its gimbal rotation angles back to SPAN. These angles are used to recalculate the lever arm at the rate that they are received. SPAN will also be able to output a gimbal solution at the rate the gimbal angles are received.

3.12.1 Reference Frame Description

There are several frames of reference involved when dealing with a gimbal mount. The frames are all very similar, but can be quite confusing due to small differences. Below are all frames applicable to the implementation of the variable lever arm:

Frame	Description	Notation
IMU Body frame	The physical IMU axes	(b)
Vehicle frame	Default reference frame for attitude output in SPAN logs	(v)
Mount body frame	The physical axes of the gimballed mount	(m)
Gimbal body frame	The physical axes of the gimbal plane. This frame matches the mount body frame when gimbal angles are zero and rotates relative to the mount body frame when the gimbal is active.	(g)
Mount computation frame	Mount body frame transformed to ensure the Mount Computation Z axis points upwards. The attitude output in the GIMBALLEDPVA log references this frame.	(mc)
User Output Frame	An arbitrary frame, used to define the desired reference for attitude output, typically matching a gimbal mounted sensor	(ou)
Mark Output Frame	An arbitrary frame, used to define the desired reference for attitude output for the MARKxPVA logs, typically matching a gimbal mounted sensor	(om)

Figure 21: Sample Configuration on the next page and *Figure 22: Operating Gimbal* on the next page illustrate a basic scenario for the information in the table above. *Figure 21: Sample Configuration* on the next page shows a possible configuration for the mount body frame, mount computation frame and IMU body frame, with the gimbal in a locked position. The extra rotation commands required to configure Variable Lever Arm for this setup are:

```
SETINSROTATION RBM 180 0 0
SETINSROTATION USER 0 0 90
SETINSROTATION RBV 0 0 -90
```

Figure 22: Operating Gimbal on the next page shows the gimbal in operation; the gimbal platform has moved relative to the mount body frame. The gimbal frame and IMU Body frame move together, as does the user output (or mark output) frame.

Figure 21: Sample Configuration

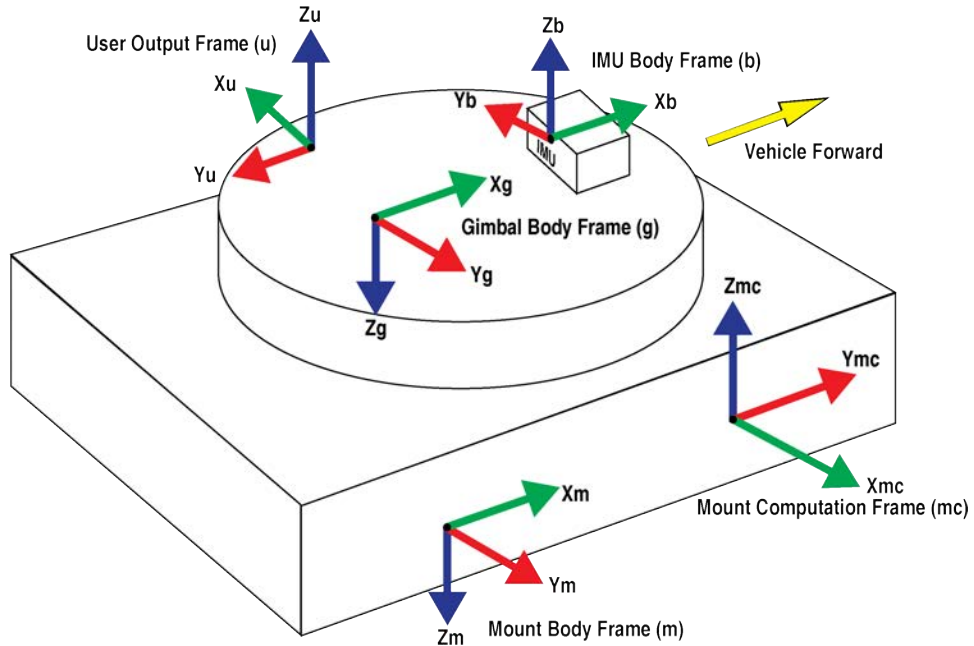
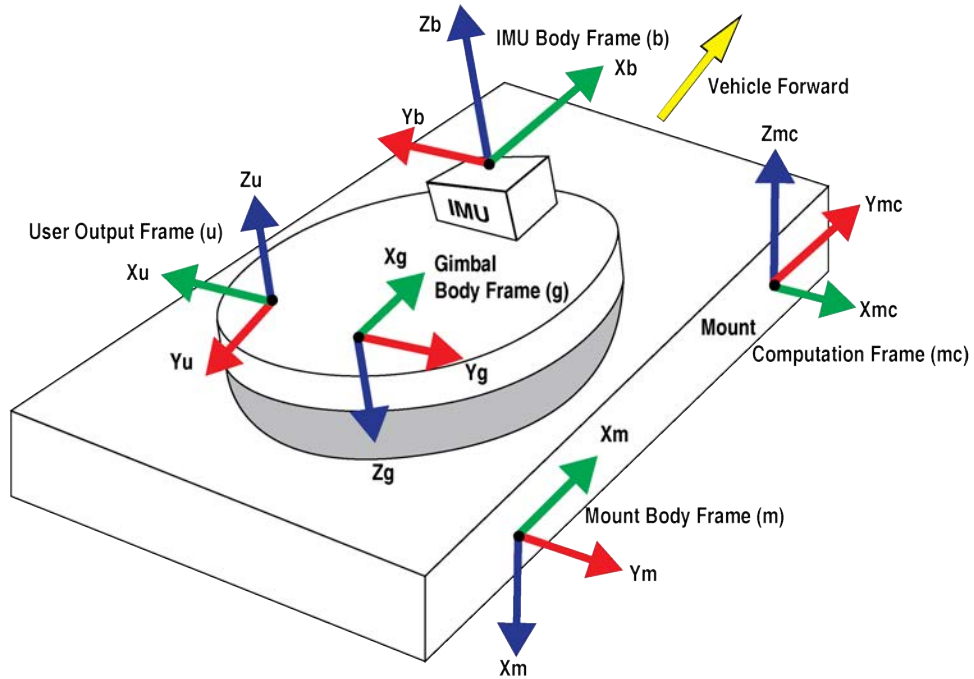


Figure 22: Operating Gimbal



3.12.2 How to Use Variable Lever Arm

The variable lever arm functionality is simple to use in a SPAN system. It requires the input of gimbal angles from the camera mount or platform that the IMU is mounted on. After that is

provided, the system will automatically compute the variable lever arm and produce several messages for output.

Ensuring a proper variable lever arm is important for SPAN performance.

Basic I/O

The variable lever arm functionality is based on the input of **INPUTGIMBALANGLE** command. This command specifies the right-handed rotation angles from the **mount body frame (m)** to the **gimbal body frame (g)**, with the order of rotations Z-X-Y. Entering this command will automatically cause the system to rotate the static lever arm into the latest gimballed frame. The update rate of the variable lever arm depends on the rate of the gimbal commands which can be entered at 1 to 50 Hz. If an **INPUTGIMBALANGLE** command is not received for over 1 second then the system will return to using the static lever arm.

In addition to using the variable lever arm internally, the following information is available to the user.

Table 15: Logs used with Variable Lever Arm

Log	Description
VARIABLELEVERARM	This log displays the calculated variable lever arm. The VARIABLELEVERARM log is output in IMU Body frame.
GIMBALLEDPVA	This log has the same format as the INSPVA log, but displays the position, velocity and attitude related back to the Mount Computation frame. The INSPVA log always displays where the IMU is truly pointing (adjusted by the SETINSROTATION RBV command). When the gimbal mount is in its zero locked position, the GIMBALLEDPVA log will match the standard INSPVA log.
INSPVA, INSPVAS, INSPVAX	The INSPVA log is synchronous so does not depend on the entry of the INPUTGIMBALANGLE command. However when the gimbal angles are non-zero, the INSPVA log no longer represents the orientation of the gimbal mount / vehicle, but rather the current orientation of the unlocked gimbal platform. If the orientation of the gimbal mount / vehicle are important, use the GIMBALLEDPVA log.

Rotations and Translations

For the information provided by the system to be meaningful, the following offsets have to be set correctly. By default the system assumes that the IMU Body frame, gimbal mount and Mount Body frame coincident. If this is not the case then additional commands are necessary to relate all of the different frames together using the commands below. If attitude output is desired relative to an external camera, this can also be configured using these commands.

Table 16: Commands used with Variable Lever Arm

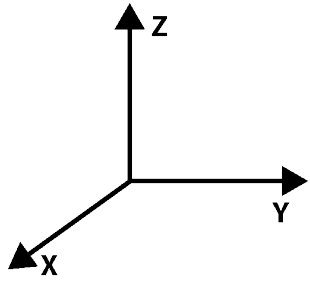
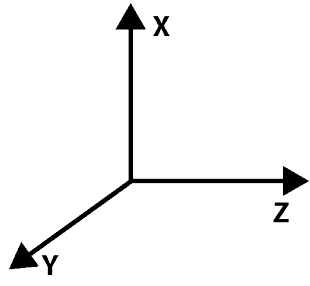
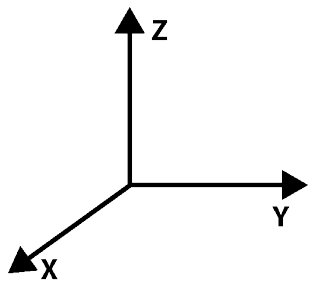
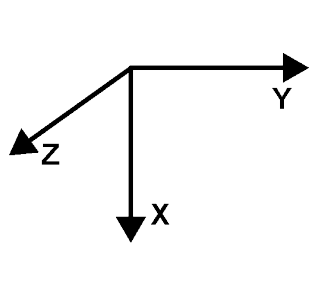
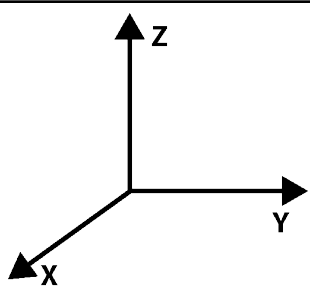
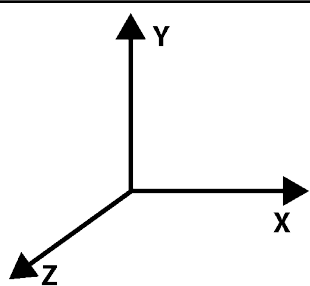
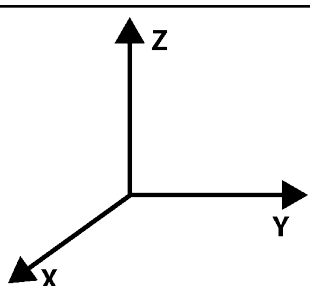
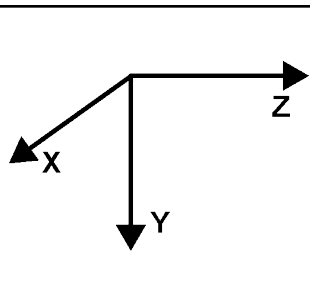
Command	Purpose
SETINSROTATION RBV	This command provides the orientation of the IMU Body frame while the gimbal frame is in the locked null position. This is required information before the SPAN system can complete an inertial alignment. The SETINSROTATION RBV command relates the IMU Body frame (b) to the Vehicle frame (v). Once an RBV rotation has been provided, default attitude output will be referenced to the Vehicle frame.
SETINSROTATION RBM	This command relates the IMU Body frame (b) to the Mount Body frame (m). This information is required for interpreting the rotation angles from the VARIABLELEVERARM log correctly.
SETINSROTATION USER	By default, attitude information output by SPAN is for the vehicle frame. If attitude output is required to be referenced to another frame (typically the axes of a gimbal-mounted sensor), the USER offset can be used to rotate the attitude output in general SPAN logs to this frame.
SETINSROTATION MARKx	Similar to the user rotation, this rotation can be used to change the attitude output reference frame for the MARKxPVA logs.
SETINSTRANSULATION GIMBAL	This command provides the offset from the IMU center of navigation to the gimbal center of navigation. This is an optional translation used by Inertial Explorer for post-processing.

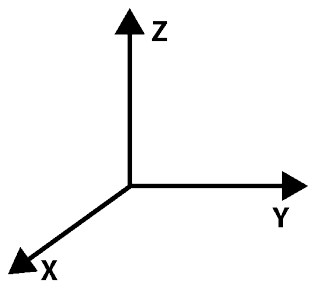
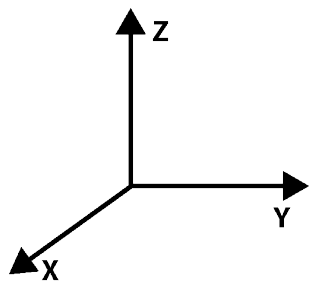
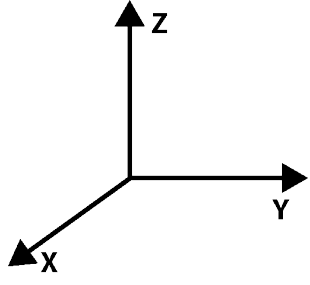
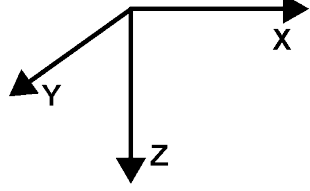
3.12.3 The Mount Computation Frame

The Mount Computation frame is determined by applying a standardized transformation to the Mount Body frame, to ensure that the Z axis of the Mount Computation frame points upwards. The attitude output in the **GIMBALLEDPVA** log provides the attitude of the Mount Computation frame.

The user does not need to configure the Mount Computation frame, it is derived from the IMU Body frame to Mount Body frame rotation (RBM), set using the **SETINSROTATION** command.

Table 17: Full Mapping Definition

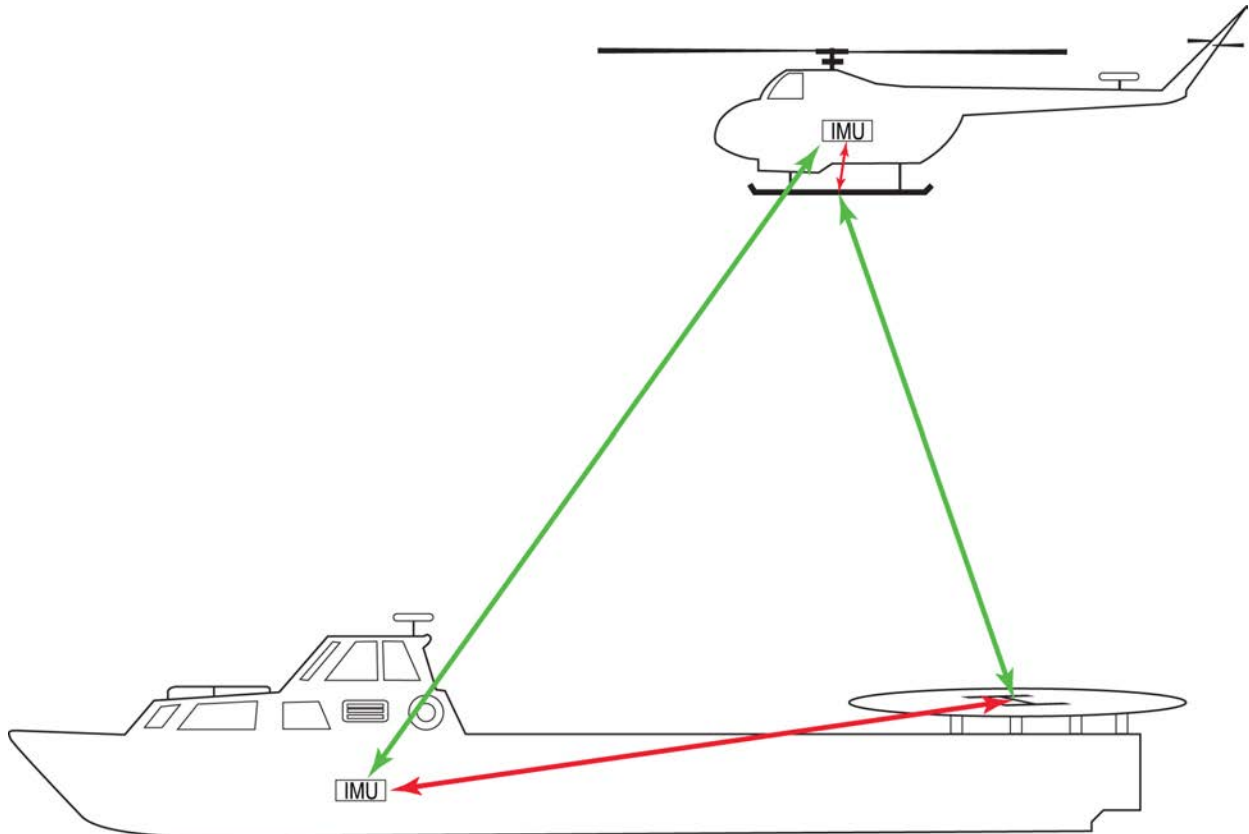
Mapping	Mount Computation Frame Axis	Mount Computation Frame	Mount Body Frame Axis	Mount Body Frame
1	X		Y	
	Y		Z	
	Z		X	
2	X		Z	
	Y		Y	
	Z		-X	
3	X		Z	
	Y		X	
	Z		Y	
4	X		X	
	Y		Z	
	Z		-Y	

Mapping	Mount Computation Frame Axis	Mount Computation Frame	Mount Body Frame Axis	Mount Body Frame
5 (default)	X		X	
	Y		Y	
	Z		Z	
6	X		Y	
	Y		X	
	Z		-Z	

3.13 Relative INS

NovAtel's Relative INS technology generates a position, velocity and full attitude vector between two SPAN systems. One is the Master receiver and the other is the Rover receiver. Once configured, the Master receiver begins transmitting corrections to the Rover receiver. Relative information is created and the system begins filling the **RELINSPVA** log and **SYNCRELINSPVA** log on the Rover receiver. The **RELINSPVA** log is then transmitted back to the Master receiver for output.

The data link required must be able to support [864bits+108bits x #obs tracked per second]. The **RELINSPVA** log is requested ONNEW (available from 1Hz-20Hz depending on the setup of the **RELINSAUTOMATION** command) while the **SYNCRELINSPVA** log can be requested ONTIME at up to 200Hz (at the rover only). Position and velocity solutions are differenced in the ECEF frame and then rotated into the local level. The Relative offset vector that is output is dependent on Master/Rover's precise RTK vector and their eccentric offset vectors (optional offset provided using the **USER** parameter in the **SETINSTRANSLATION** command), shown in *Figure 23: Relative INS Example* on the next page.

Figure 23: Relative INS Example

An important command that can be used with Relative INS to manually change the maximum amount of time to use RTK data is the **RTKTIMEOUT** command. This command is used to set the maximum age of RTK data to use when operating as a rover station. RTK data received that is older than the specified time is ignored. The default is 60 seconds, however when using Relative INS, it is suggested this be set to 5 seconds by sending the command **RTKTIMEOUT 5**.



For information about the **RTKTIMEOUT** command, refer to the OEM7 Commands and Logs Reference Manual (OM-20000169).

3.13.1 Configure Relative INS

To configure the receivers to begin computing the relative information:

1. Setup a link between the receivers that will be used to transfer data (for example, radios).
2. Enable the transfer of relative corrections between receivers using one of the methods below.
 - Send the **RELINSAUTOMATION** command only at the Rover receiver
 - Send the **RELINSCONFIG** command at both the Master and Rover receiver



To configure Relative INS using the **RELINSAUTOMATION** command, the mater and rover receivers must be communicating using a COM port. If the master and rover are communicating via an ICOM port, the **RELINSCONFIG** command must be used.



The Model option must be present on both the rover and master for the Relative INS feature to be enabled.

Chapter 4 SPAN with Dual Antenna

NovAtel's ALIGN® heading technology generates distance and bearing information between a "master" and one or more "rover" receivers.

SPAN with Dual Antenna provides the hardware necessary to run an ALIGN baseline with an IMU and a second receiver.

With SPAN, the ALIGN GNSS baseline can be used to assist the initial alignment of the SPAN solution. In addition, the ALIGN baseline solution will aid the heading solution from the receiver if the heading drifts due to slow or constant dynamics.

ALIGN is capable of a 10 Hz heading output rate when integrated with the OEM7 receiver.

4.1 Installation

The hardware for SPAN with Dual Antenna is installed in a manner similar to other SPAN systems. Some points to consider during your installation are:

1. Install the IMU and the two antennas in the vehicle such that the relative distance between them is fixed.
2. The antennas should be mounted where the view of the satellites will not be obstructed by any part of the vehicle. As heading accuracy is dependent on baseline length, mount the antennas as far apart as possible. A minimum separation distance of 1 metre is recommended.
3. The lever arms or distance from the IMU to the antennas needs to be fixed and accurately measured using the coordinate axes defined on the outside of the IMU. The baseline between the two antennas does NOT need to be aligned with the vehicle axes or with the axes of the IMU.
4. Both receivers need to be powered and connected to each other via COM 2 before sending any configuration commands. It does not matter which receiver is powered on first, or how long they are both powered before sending any commands.



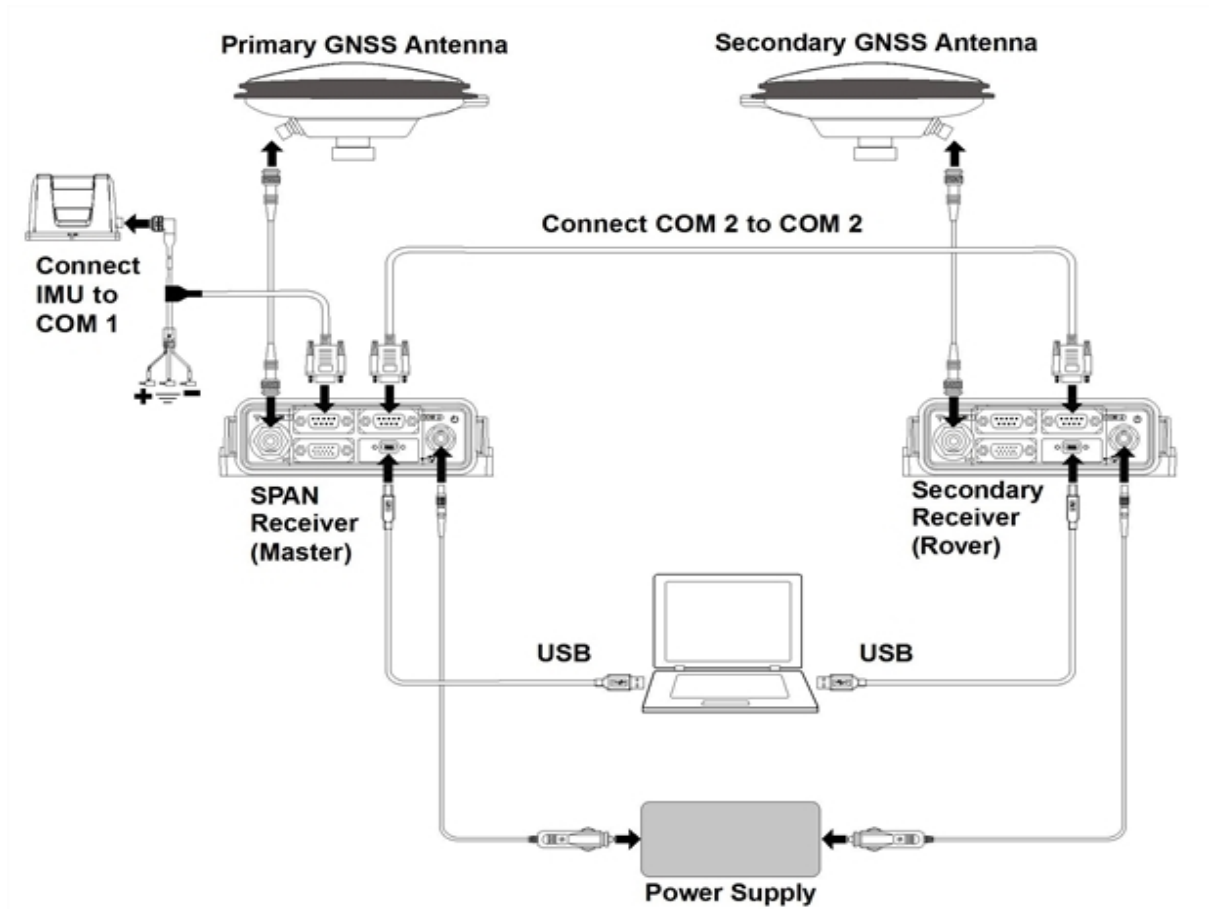
SPAN with Dual Antenna operation assumes the dedicated use of the COM 2 port for communication between receivers. If this port is required for another function on the SPAN-enabled master, the port can be changed using the **DUALANTENNAPORTCONFIG** command. However, the rover must always use COM2.



For information about connecting the ALIGN master and rover receivers using a port that is not a serial COM port (e.g. Ethernet), contact NovAtel Customer Support.

The two receivers need to be set up as shown in the example in *Figure 24: SPAN - Dual Antenna Installation* on the next page.

Figure 24: SPAN - Dual Antenna Installation



4.2 Configuring ALIGN with SPAN

Before configuring the ALIGN solution, the two receivers should both be powered on and connected directly between COM 2 of the SPAN receiver and COM 2 of the second receiver through either a null modem cable or an appropriate radio connection.



The rover receiver must be an ALIGN-capable model.

To enable the dual-antenna ALIGN solution to aid the INS alignment and provide heading updates, the offset between the antennas and the IMU must be known. This is achieved by entering lever arms to both antennas, using the **SETINSTRANSULATION** command.

To configure SPAN with ALIGN Aiding:

1. Enter the lever arm from the IMU to the primary antenna (primary antenna is connected to the SPAN receiver).

Abbreviated ASCII example:

```
SETINSTRANSULATION ANT1 0.54 0.32 1.20 0.03 0.03 0.05
```

2. Enter the lever arm from the IMU to the secondary antenna (secondary antenna is connected

to the second receiver).

Abbreviated ASCII example:

```
SETINSTRANSFORMATION ANT2 0.54 2.32 1.20 0.03 0.03 0.05
```

Alternately, the angular offset between the dual-antenna baseline (from primary GNSS antenna to secondary GNSS antenna) and the IMU frame forward axis is entered directly via the **ALIGN** parameter of the **SETINSROTATION** command.



We recommend entering the lever arms rather than entering the angular offset as this is easier to measure and will lead to better overall accuracy.

Refer to the OEM7 Commands and Logs Reference Manual (OM-20000169) for the syntax of the above commands.

As with all ALIGN-capable products, the GNSS baseline solution is available from the **GPHDT** log and **HEADING2** log. For INS heading, use the **INSATT** log or **INSPVA** log.

The SPAN system can be configured for different alignment routines depending on the motion conditions experienced during the alignment period. For example, in marine applications, the dynamics required for either a coarse or kinematic alignment cannot be guaranteed, so a different alignment routine is required.

The different alignment routines are described in *Configuring SPAN with ALIGN* below.

4.3 Configuring SPAN with ALIGN

The SPAN receiver can be configured for different alignment routines depending on the motion conditions experienced during the alignment period. For example, in marine applications, the dynamics required for either a coarse or kinematic alignment cannot be guaranteed, so a different alignment routine will be required.

The different alignment routines are described in the following sections:

4.3.1 Alignment on a Moving Vessel - Aided Transfer Alignment

This alignment routine is the preferred dual antenna alignment method. It is used if the alignment mode is set to AIDED_TRANSFER using the **ALIGNMENTMODE** command, and can be used if the alignment mode is set to AUTOMATIC.

If your vehicle is not stationary during the alignment, such as may be the case on a ship, use the Aided Transfer Alignment routine. This alignment method uses the ALIGN baseline solution to perform an instantaneous alignment of the vehicle attitude.

The alignment happens instantaneously after the receiver establishes communication with the IMU and computes a verified, fixed integer, ALIGN solution. The INS status changes to INS_ALIGNMENT_COMPLETE or INS_SOLUTION_GOOD, depending on the variances of the ALIGN solution, and the measured lever arm/external heading offset.

To guarantee the use of this alignment mode, the configuration command ALIGNMENTMODE must be sent to the receiver:

```
ALIGNMENTMODE AIDED_TRANSFER
```

4.3.2 *Alignment on a Stationary Vehicle - Aided Static Alignment*

An alternative to the aided transfer alignment, the ALIGN heading can be used as a seed for a coarse static alignment. In this mode, the standard coarse alignment routine runs given the initial azimuth value. As with the transfer alignment, the first verified fixed RTK solution is used to provide the alignment seed after which the coarse alignment (INS_ALIGNING) begins. After the coarse alignment is complete, the INS status changes to INS_ALIGNMENT_COMPLETE. After the attitude accuracy has converged, the INS status changes to INS_SOLUTION_GOOD. This alignment mode is useful if the initial vehicle roll is more than 20 degrees.

To use this alignment mode, the configuration command ALIGNMENTMODE must be sent to the receiver.

```
ALIGNMENTMODE AIDED_STATIC
```

4.3.3 *Unaided Alignment*

The unaided alignment sets the SPAN system to use only single antenna alignment options (static, kinematic or manual alignment).

To use this alignment mode, the configuration command ALIGNMENTMODE must be sent to the receiver.

```
ALIGNMENTMODE UNAIDED
```

4.3.4 *Automatic Alignment Mode - Automatic Alignment (default)*

Automatic Alignment Mode Selection is the default setting for a SPAN receiver. This mode is designed to allow alignment of the system as quickly as possible, using either an aided transfer alignment (*Alignment on a Moving Vessel - Aided Transfer Alignment* on the previous page); a kinematic alignment (*Kinematic Alignment* on page 55); or a manual alignment (*Manual Alignment* on page 56).

The first available technique will be used, regardless of its relative quality. If you wish to guarantee a specific technique is used, or use an aided static alignment, you must select the desired alignment mode manually. No additional configuration is required to use this alignment routine.

4.4 SPAN ALIGN Attitude Updates

The INS heading updates are used to help constrain the azimuth drift of the INS solution whenever possible. This is of the greatest value with lower-quality IMUs and in environments with low dynamics where the attitude error is less observable. Slow moving marine or train applications are good examples of the intended use. By providing an external heading source, the solution drift can be constrained in these environments.

You can monitor the heading update status as outlined in the **INSUPDATESTATUS** log in the OEM7 Commands and Logs Reference Manual (OM-20000169).

APPENDIX A IMU Technical Specifications

The following appendices detail the technical specifications of the SPAN compatible IMUs.

- *HG1700 IMU (single-connector enclosure)* on the next page
- *IMU-CPT* on page 89
- *IMU-FSAS* on page 95
- *IMU-HG1900* on page 105
- *IMU-IGM* on page 110
- *IMU-ISA-100C* on page 118
- *IMU-KVH1750 / IMU-KVH1725* on page 129
- *IMU-LN200* on page 138
- *IMU- μ IMU* on page 143
- *LN-200 IMU (single-connector enclosure)* on page 148
- *OEM-IMU-ADIS-16488* on page 153
- *OEM-IMU-ISA-100C* on page 158
- *OEM-IMU-STIM300* on page 165
- *OEM-IMU- μ IMU* on page 169
- *Universal IMU Enclosure (HG1700, LN200)* on page 174
- *MIC - MEMS Interface Card* on page 184
- *UIC - Universal IMU Controller* on page 196

For technical specifications for the SPAN compatible receivers, see the OEM7 Installation and Operation User Manual (OM-20000168).

A.1 HG1700 IMU (single-connector enclosure)

Table 18: HG1700 IMU Physical Specifications

Physical	
IMU Enclosure Size	193 mm x 167 mm x 100 mm (7.6" x 6.6" x 3.9")
IMU Size	160 mm x 160 mm x 100 mm (6.3" x 6.3" x 3.9")
IMU + Enclosure Weight	3.4 kg (7.49 lb.)

See the following sections for more information about the HG1700 IMU.

- *HG1700 IMU Mechanical Drawings* on the next page
- *HG1700 IMU Performance* on page 87
- *HG1700 Electrical and Environmental* on page 88
- *Interface Cable for the HG1700 IMU* on page 88

A.1.1 HG1700 IMU Mechanical Drawings


 The dimensions in the following diagrams are in millimetres.

Figure 25: HG1700 Top/Bottom Dimensions

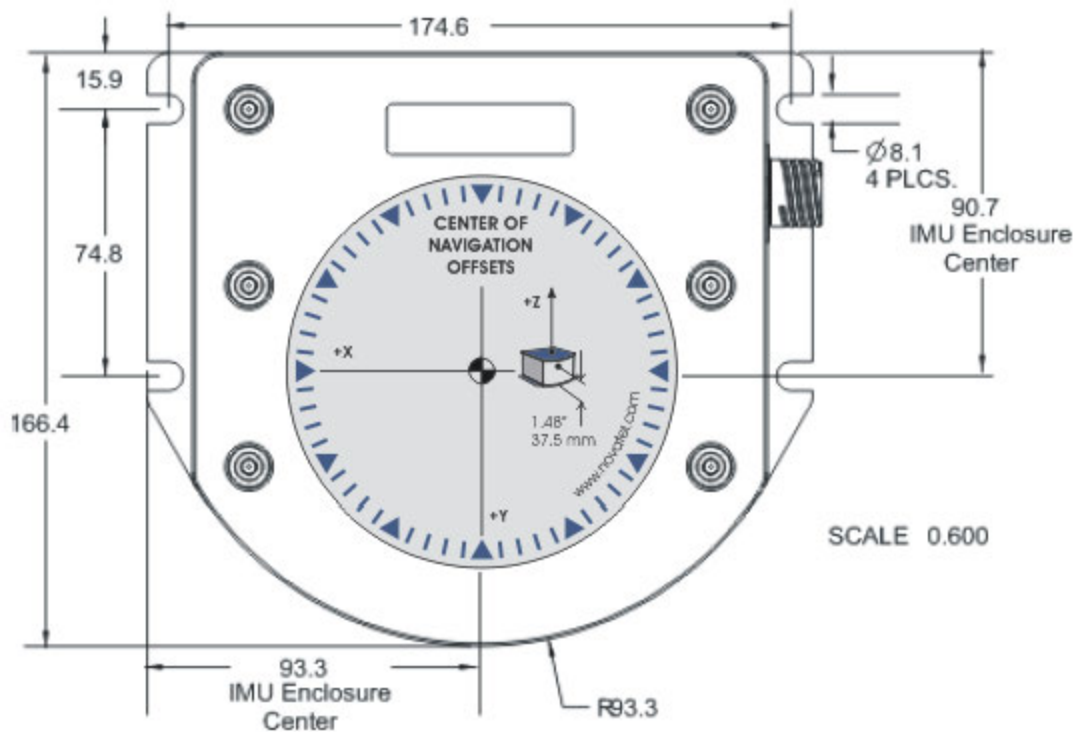
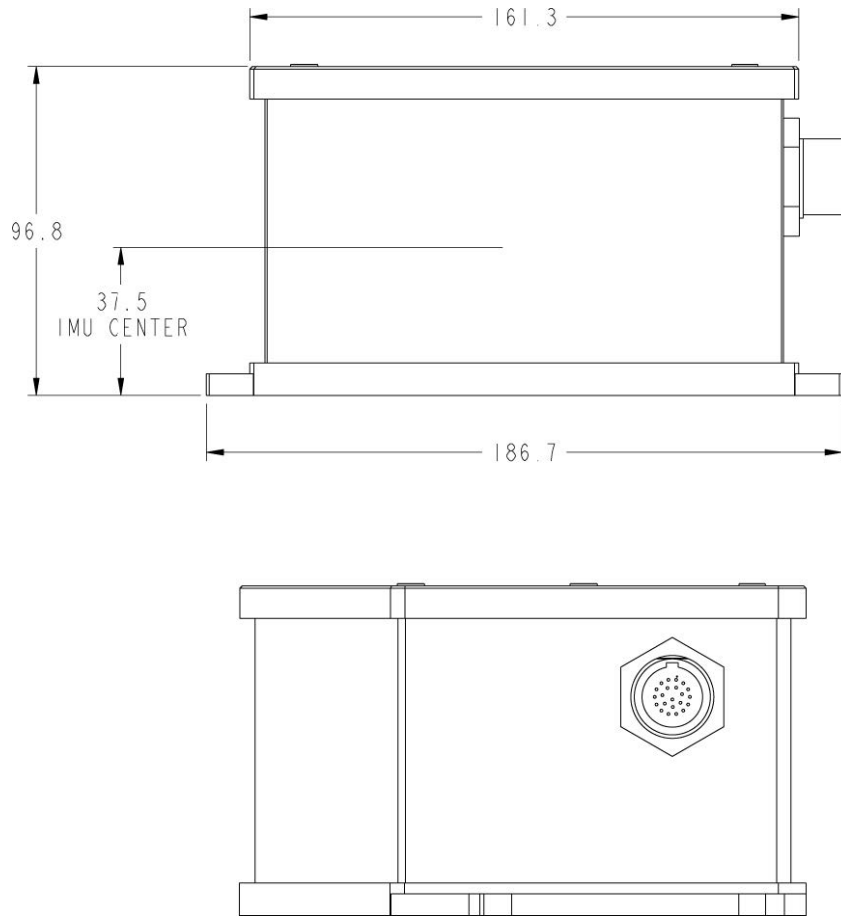


Figure 26: HG1700 Enclosure Side Dimensions



The center of Navigation, shown on the HG1700 label, for the internal IMU is the same as the enclosure center. The enclosure center measurements are labelled as IMU Enclosure Center in these figures.

A.1.2 HG1700 IMU Performance**Table 19: HG1700-AG58 IMU Performance**

Gyroscope Performance	
Gyro Input Range	±1000 degrees/s
Gyro Rate Bias	1.0 degree/hr
Gyro Rate Scale Factor	150 ppm
Angular Random Walk	0.125 degrees/rt hr
Accelerometer Performance	
Accelerometer Range	±50 g
Accelerometer Linearity	500 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	1.0 mg
Data Rate	
IMU Measurement	100 Hz

Table 20: HG1700-AG62 IMU Performance

Gyroscope Performance	
Gyro Input Range	±1000 degrees/s
Gyro Rate Bias	5.0 degrees/hr
Gyro Rate Scale Factor	150 ppm
Angular Random Walk	0.5 degrees/rt-hr
Accelerometer Performance	
Accelerometer Range	±50 g
Accelerometer Linearity	500 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	2.0 mg
Data Rate	
IMU Measurement	100 Hz

A.1.3 HG1700 Electrical and Environmental

Table 21: HG17000 Electrical Specifications

Electrical	
IMU Power Consumption	IMU-H58: 9 W (max) IMU-H62: 8 W (max)
IMU Input Voltage	+12 to +28 V DC
Receiver Power Consumption	1.8 W (typical)
System Power Consumption	13.8 W (typical)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMUs)
IMU Interface	RS-232 or RS-422

Table 22: HG17000 Environmental Specifications

Environmental (IMU)	
Temperature	Operating: -30°C to +60°C (-22°F to 140°F) Storage: -45°C to +80°C (-49°F to 176°F)
Humidity	95% non-condensing

A.1.4 Interface Cable for the HG1700 IMU

The IMU interface cable provides power to the IMU from an external power source and enables communication between the receiver and IMU. The HG1700 IMU uses the Universal IMU Enclosure Interface cable (see *Universal IMU Enclosure Interface Cable* on page 181).

A.2 IMU-CPT

Table 23: IMU-CPT Physical Specifications

Physical	
IMU Size	168 mm W X 152 mm L X 89 mm H
IMU Weight	2.29 kg

See the following sections for more information about the IMU-CPT.

- *IMU-CPT Mechanical Drawings* on the next page
- *IMU-CPT Sensor Specifications* on page 92
- *IMU-CPT Electrical and Environmental* on page 92
- *IMU-CPT Cable* on page 93

A.2.1 IMU-CPT Mechanical Drawings


 The dimensions in the following diagrams are in inches and millimetres (in square brackets).

Figure 27: IMU-CPT Side and Perspective View

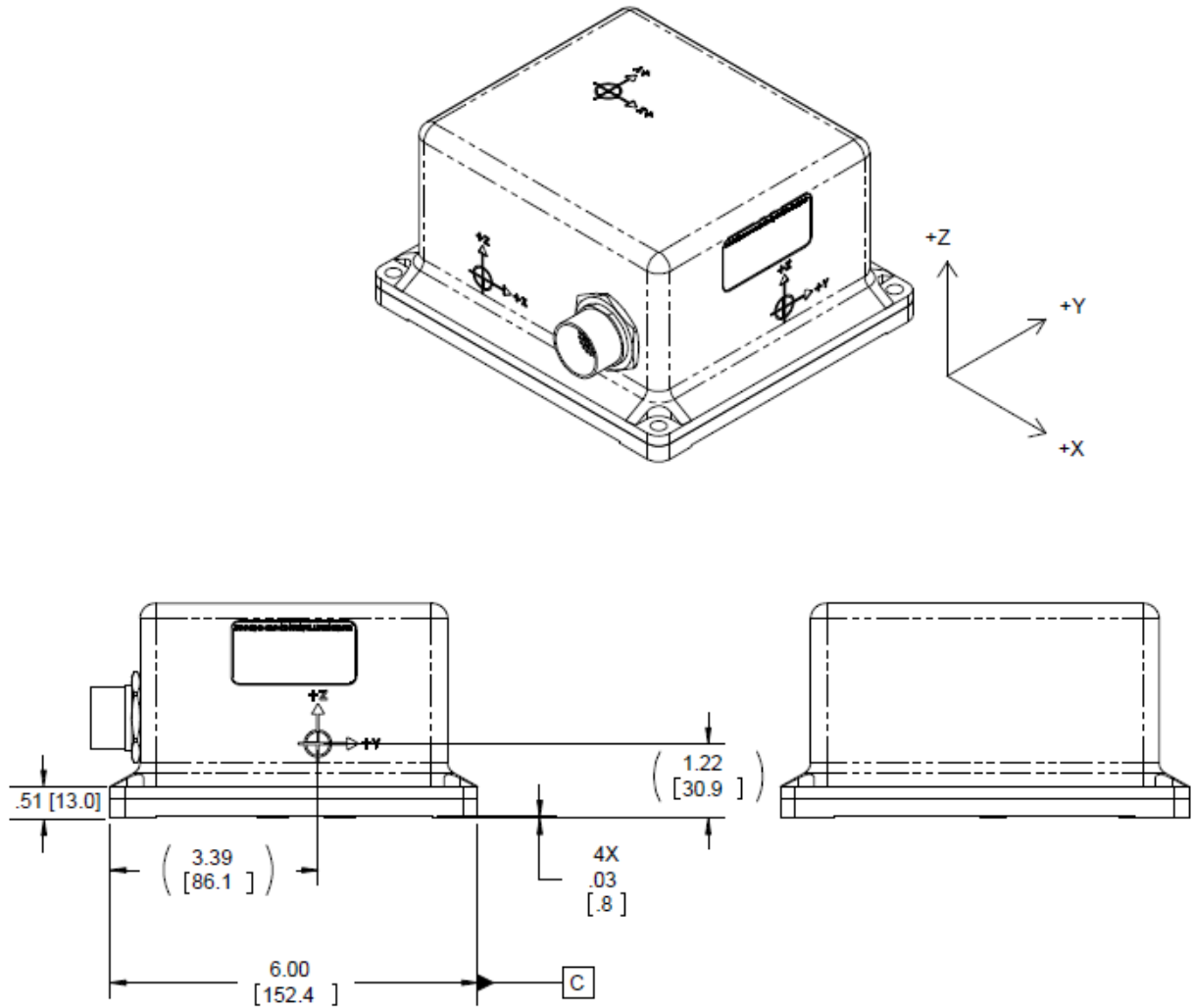
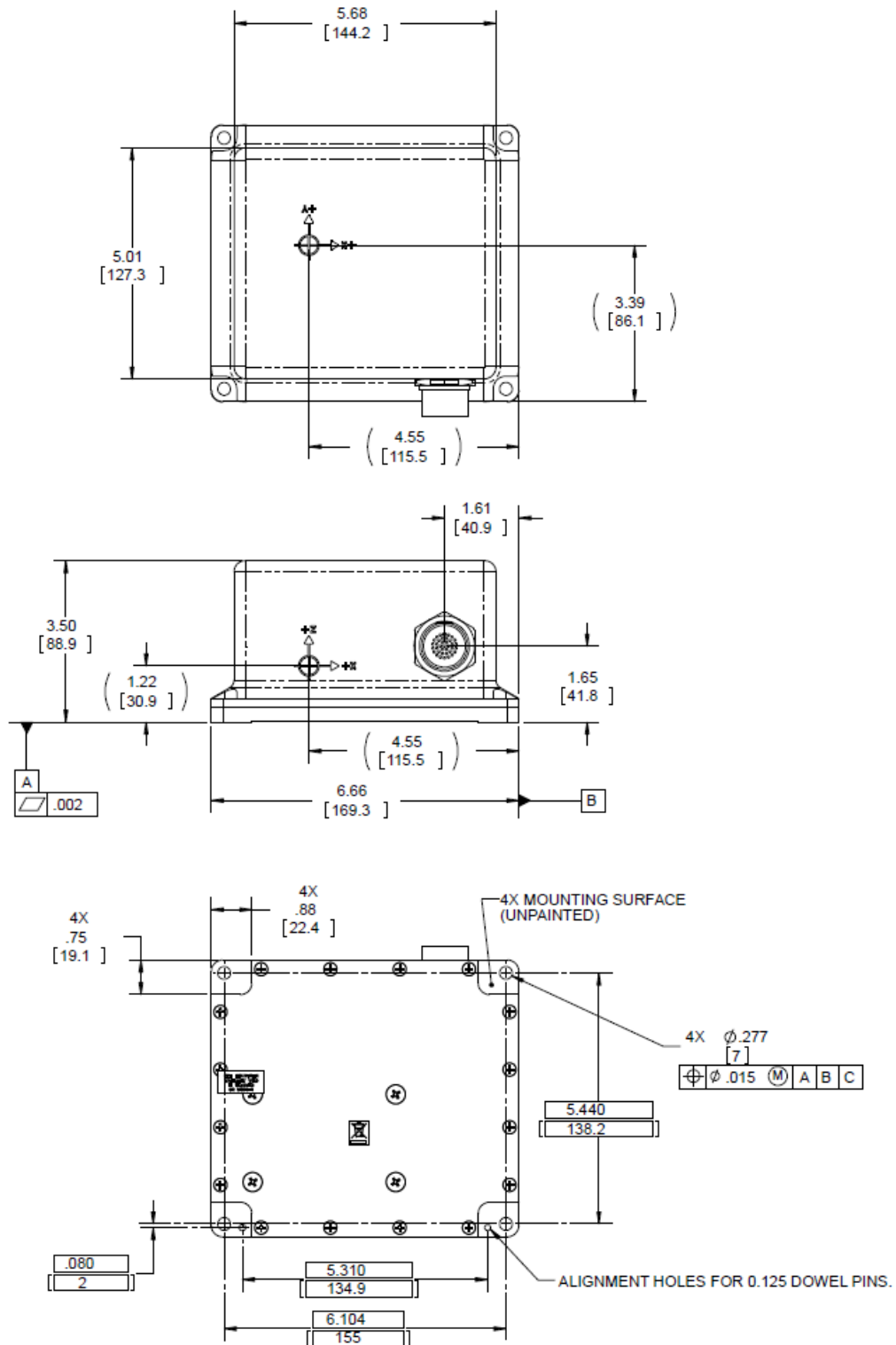


Figure 28: IMU-CPT Top, Front and Bottom View



A.2.2 IMU-CPT Sensor Specifications**Table 24: IMU-CPT Performance**

Gyroscope Performance	
Bias Offset	±20 °/hr
Turn On To Turn On Bias Repeatability (Compensated)	±3 °/hr
In Run Bias Variation, At Constant Temperature	1 °/hr @ 1σ
Scale Factor Error (Total)	1500 ppm, 1σ
Scale Factor Linearity	1000 ppm, 1σ
Temperature Dependent SF Variation	500 ppm, 1σ
Angular Random Walk	0.0667 °/√hr @ 1σ
Maximum Input	±375 °/sec
Accelerometer Performance	
Bias Offset	±50 mg
Turn On To Turn On Bias Repeatability	±0.75 mg
In Run Bias Variation, At Constant Temperature	0.25 mg @ 1σ
Temperature Dependent Bias Variation	0.5 mg/°C @ 1σ
Scale Factor Error (Total)	4000 ppm, 1σ
Temperature Dependent SF Variation	1000 ppm, 1σ
Accelerometer Noise	55 μg/√Hz @ 1σ
Bandwidth	50 Hz
Accelerometer Bias	±10 g
Data Rate	
IMU Measurement	100 Hz

A.2.3 IMU-CPT Electrical and Environmental**Table 25: IMU-CPT Electrical Specifications**

Electrical	
Input Power	9 - 18 VDC
Power Consumption	13 W (max)

Electrical	
Power and I/O Connector	MIL-DTL-38999 Series 3
Start-Up Time (Valid Data)	< 5 seconds

Table 26: IMU-CPT Environmental Specifications

Environmental	
Temperature, operational	-40°C to +65°C
Temperature, non-operational	-50°C to +80°C
Vibration, operational	6 g rms, 20 Hz -2 KHz
Vibration, non-operational	8 g rms, 20 Hz -2 KHz
Shock, operational	7g 6-10 msec, 1/2 sine
Shock, non-operational	60 g 6-10 msec, 1/2 sine
Altitude	-1000 to 50,000 ft.
Humidity	95% at 35°C, 48 hrs
MTBF	≥ 10,500 hours

A.2.4 IMU-CPT Cable

The NovAtel part number for the IMU-CPT cable is 01018966. This cable provides power to the IMU from an external power source and enables communication between the receiver and the IMU.

Figure 29: IMU-CPT Development Terminated Cable

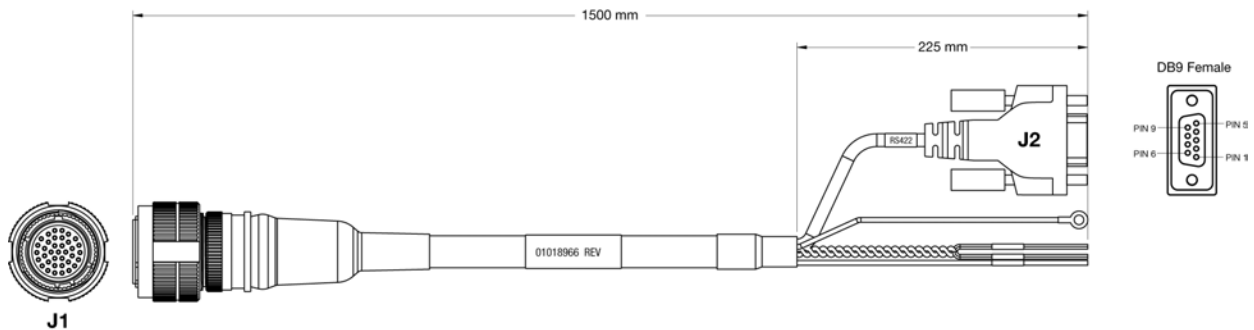


Table 27: IMU-CPT Connector Pinout Descriptions

J1 Pin #	Function	J2 (Female DB9) Pin #	Bare Connectors
1	Power Return		Labelled Pin 1
2	9-16 VDC Power Input		Labelled Pin 2
3-20	Reserved		
21	IMU RS422 TX+	2	
22	IMU RS422 TX-	8	
23-24	Reserved		
25	IMU RS422 Signal Ground	5	
26-34	Reserved		
35	TOV Output	9	
36	External Clock Input	1	
37	Chassis GND		Labelled Pin 37
	Chassis GND		Ring lug

Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU-CPT cable (01018966).

Table 28: Connectors

Connector	Description
J1	MIL-DTL 38999, 37 connector, plug
J2	DB-9, female

Table 29: Maximum Cable Length

IMU	RS-422
IMU-CPT	< 1.5 metres

A.3 IMU-FSAS

Table 30: IMU-FSAS Physical Specifications

Physical	
IMU Size	128 mm x 128 mm x 104 mm (5.04" x 5.04" x 4.09")
IMU Weight	2.1 kg (4.63 lb.)

See the following sections for more information about the IMU-FSAS.

- *IMU-FSAS Mechanical Drawings* on the next page
- *IMU-FSAS Performance* on page 99
- *IMU-FSAS Electrical and Environmental* on page 99
- *Interface Cable for IMU-FSAS* on page 100
- *IMU-FSAS Cable with Odometer* on page 100
- *IMU-FSAS Odometer Cabling* on page 102

A.3.1 IMU-FSAS Mechanical Drawings


 The dimensions in the following diagrams are in millimetres.

Figure 30: IMU-FSAS Top Dimensions

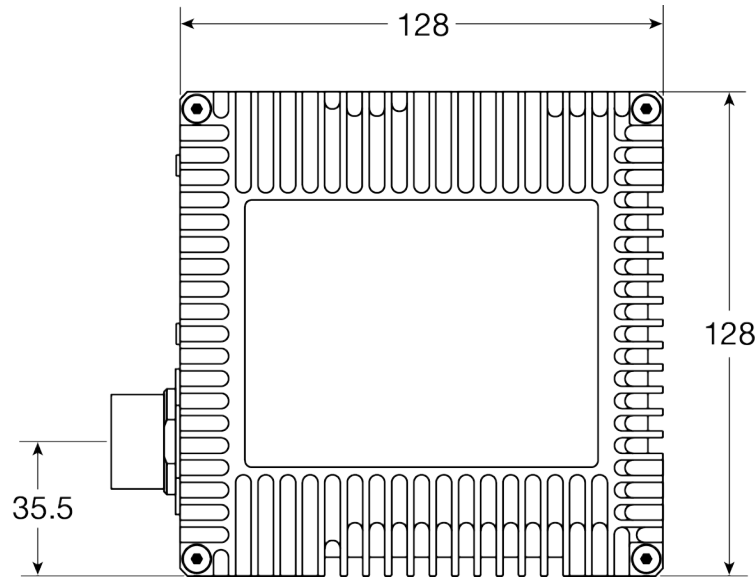


Figure 31: IMU-FSAS Bottom Dimensions

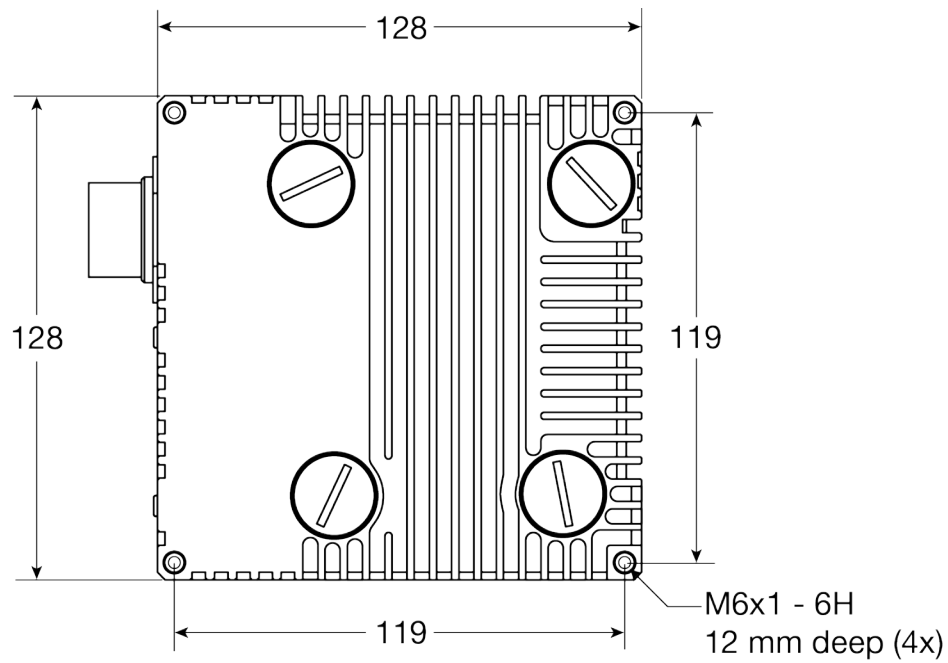


Figure 32: IMU-FSAS Side Dimensions

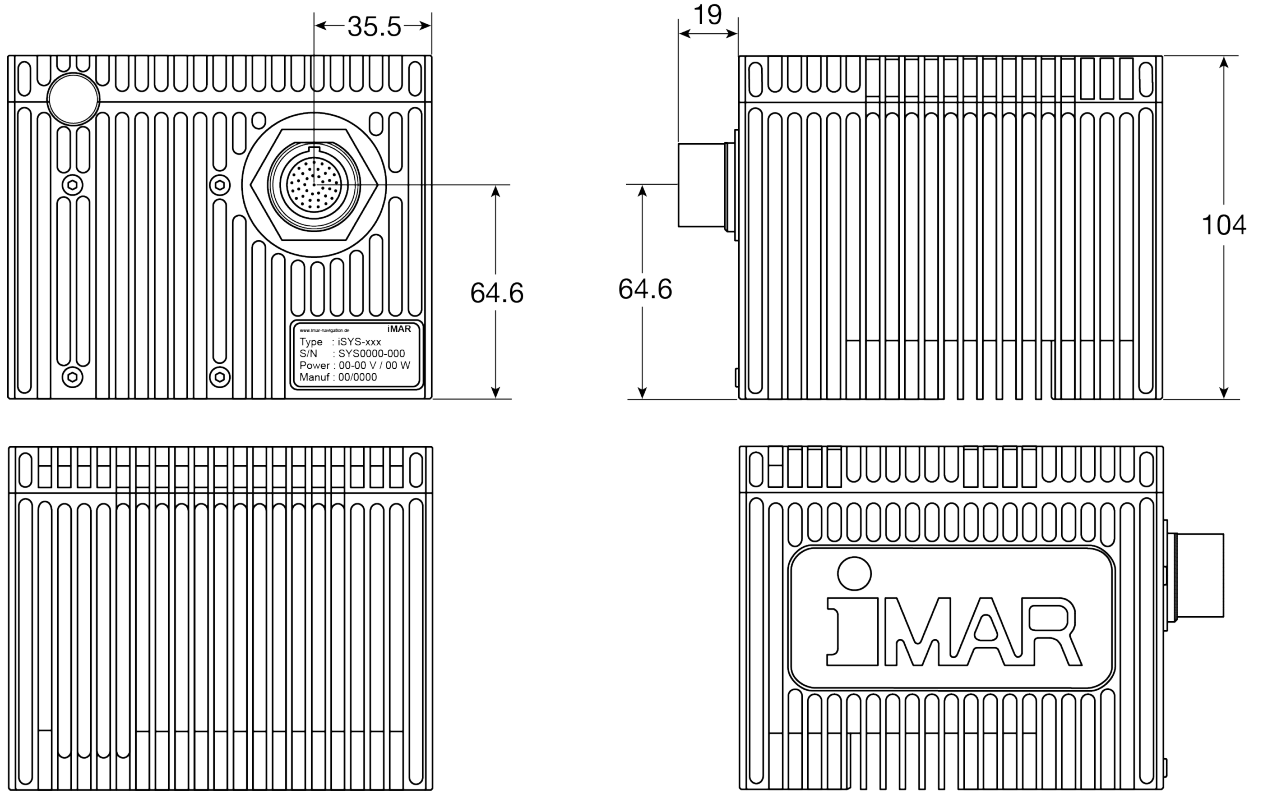
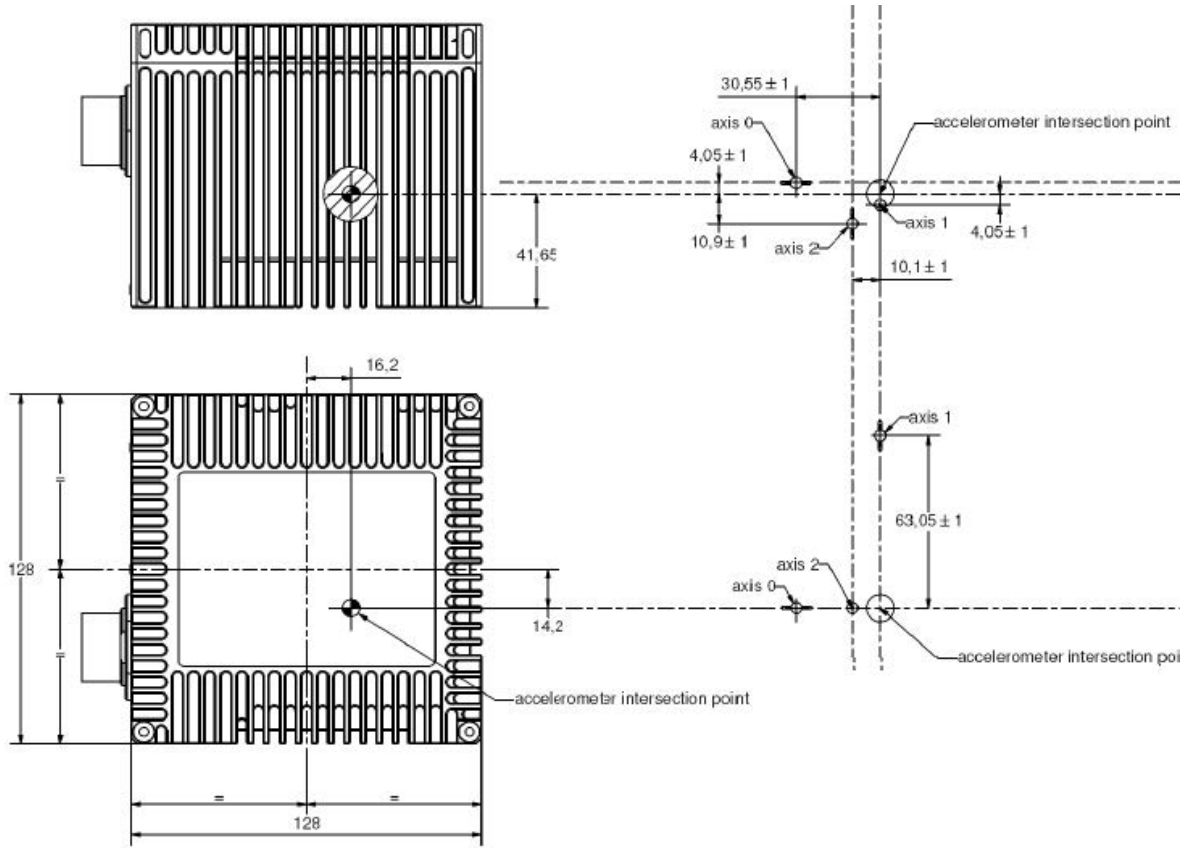


Figure 33: IMU-FSAS Center of Navigation



A.3.2 IMU-FSAS Performance**Table 31: IMU-FSAS Performance**

Gyroscope Performance	
Gyro Input Range	±450 °/s
Gyro Rate Bias	<0.75°/hr
Gyro Rate Scale Factor	300 ppm
Angular Random Walk	0.1 °/sq rt hr
Accelerometer Performance	
Accelerometer Range	±5 g (±20 g optional)
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	1.0 mg
Data Rate	
IMU Measurement	200 Hz

A.3.3 IMU-FSAS Electrical and Environmental**Table 32: IMU-FSAS Electrical Specifications**

Electrical	
IMU Power Consumption	16 W (max)
IMU Input Voltage	+10 to +34 V DC
Receiver Power Consumption	1.8 W (typical)
System Power Consumption	13.8 W (typical)
Input/Output Connectors	MIL-C-38999-III
IMU Interface	RS-422

Table 33: IMU-FSAS Environmental Specifications

Environmental	
Operating Temperature	-40°C to +71°C (-40°F to 160°F)
Storage Temperature	-40°C to +85°C (-40°F to 185°F)
Humidity	95% non-condensing

A.3.4 Interface Cable for IMU-FSAS

The IMU interface cable can be one of the following cables:

Cable NovAtel Part Number	NovAtel Part Number	Comment	For more information
Universal IMU Enclosure Interface cable	01018977	For standard pinout enclosures.	See <i>Universal IMU Enclosure Interface Cable</i> on page 181
IMU-FSAS cable with ODO	01018388	For standard pinout enclosures. Includes an additional connector for odometer cabling.	See <i>IMU-FSAS Cable with Odometer</i> below

A.3.5 IMU-FSAS Cable with Odometer

The NovAtel part number for the IMU-FSAS cable with Odometer is 01018388 (see *Figure 34: IMU-FSAS Interface Cable with Odometer* below). This cable:

- provides power to the IMU from an external power source
- enables input and output between the receiver and the IMU
- enables input from an optional odometer

See also iIMU-FSAS Odometer Cabling on page 113.

Figure 34: IMU-FSAS Interface Cable with Odometer

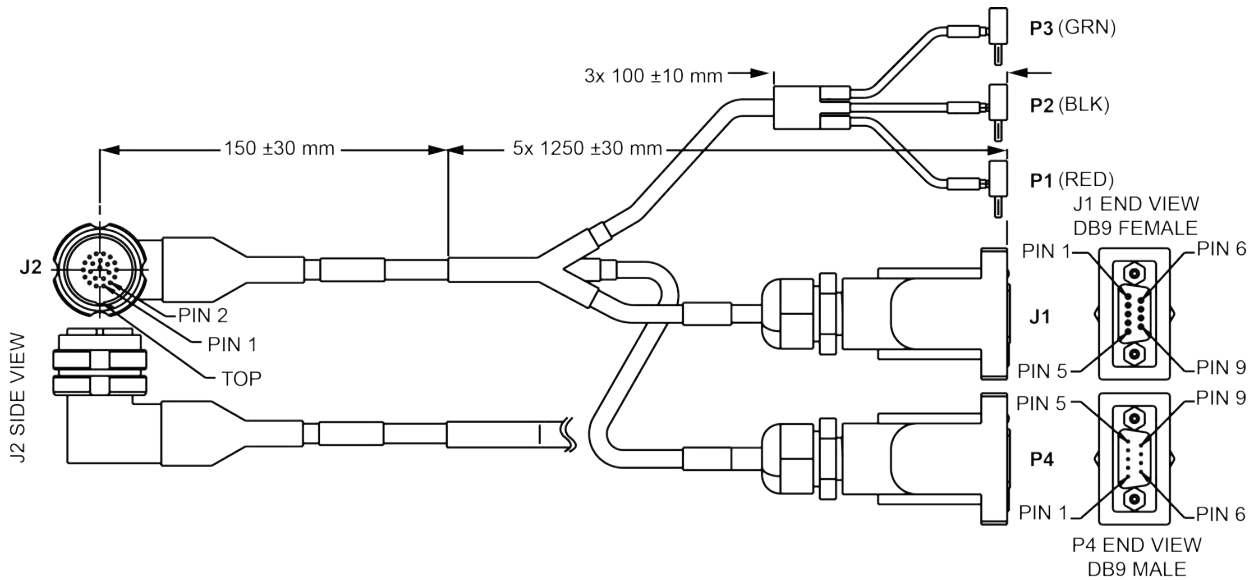


Table 34: IMU-FSAS Cable with Odometer Pinout

MIL-C-38999 III Connector Pin	Function	Power 4 mm plugs	J1 Female DB9	P4 Male DB9	Comments
1	Vin(-)	Color: black Label: Vin (-)			Power ground
22	Vin(-)				
2	ODO_AN			7	Odometer input A(-), opto-coupler: +2 to +6 V (RS-422 compatible)
4	ODO_A			6	Odometer input A(+), opto-coupler: +2 to +6 V (RS-422 compatible)
3	Vin(+)	Color: red Label: Vin (+)			+10 to +34 VDC
21	Vin(+)				
5	Not used				
6	Not used				
7	DAS(+)		1		Shielded data acquisition signal (LVCMOS to VARF)
9	DAS GN (-)		5		Shielded ground reference for data acquisition and control signals
8	Reserved				
10	Reserved				
11	OEM_CTS/ Rx-		8		Twisted pair; serial data output signal / RS-422(-)
12	OEM_Rx/ Rx+		2		Twisted pair; serial data output signal / RS-422(+)
13	Reserved				
14	DGND		5		Digital ground
15	DGND		5		Digital ground
16	ODO_B			3	Odometer input B(+), opto-coupler: +2 to +6 V (RS-422 compatible)

MIL-C-38999 III Connector Pin	Function	Power 4 mm plugs	J1 Female DB9	P4 Male DB9	Comments
17	ODO_BN			1	Odometer input B(-), opto-coupler: +2 to +6 V (RS- 422 compatible)
18	Reserved				
19	OEM_Tx/ Tx+		3		Twisted pair; serial data in / RS-422(+)
20	OEM_ RTS/ Tx		7		Twisted pair; serial data in / RS-422(-)

Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU-FSAS cable with Odometer (01018388).

Table 35: Connectors

Connector	Description
J1	DB-9, female
J2	MIL-DTL-38999 III, plug
P4	DB-9, male

**Table 36: Maximum
Cable Length**

IMU	RS-422
iIMU-FSAS	< 1.5 metres

A.3.6 IMU-FSAS Odometer Cabling

The IMU-FSAS with the -O wheel sensor option provides wheel sensor input from the Distance Measurement Instrument (DMI) through the DB-9 connector labelled "ODO" on the IMU interface cable. The DMI data goes through the IMU and then into the SPAN receiver through the serial communication line.

There are two DMI products that are compatible with the IMU-FSAS system:

- iMWS-V2 (Magnetic Wheel Sensor) from iMAR

A magnetic strip and detector are installed inside the wheel. The signal then goes through a box that translates the magnetic readings into pulses that are then passed through the cable into the ODO connector on the IMU cable.

Figure 35: iMAR iMWS Pre-Installed

The iMAR iMWS-V2 sensor is on the inside of the wheel so that all you can see in the vehicle is the grey signal converter box.

iMAR provides a sensor that operates with a magnetic strip glued inside the rim of a non-drive wheel and a special detector (iRS) mounted on the inside of the wheel (the disk of the wheel suspension, brake cover or brake caliper holder). Details are shown in the installation hints delivered with the system.

- Wheel Pulse Transducer CWPTA411 (WPT) from Kistler

A transducer traditionally fits to the outside of a non-drive wheel. A pulse is then generated from the transducer which is fed directly to the ODO connector on the IMU cable.

Figure 36: Kistler WPT

The WPT mounts to the wheel lug nuts via adjustable mounting collets. The torsion protection rod, which maintains rotation around the wheel axis, affixes to the vehicle body with suction cups. Refer to the Kistler WPT (part number CWPTA411) user manual for mounting instructions.

The NovAtel IMU interface cable with ODO provides power to the IMU from an external source, enables input and output between the receiver and IMU and provided connections for odometer use. See also *SPAN Wheel Sensor Configuration* on page 66.



The DMI runs only one output line (A).



SPAN specifies that the maximum pulse frequency for a wheel sensor input to SPAN is 1 MHz.

You can use our interface cable with the ODO connector to plug directly into the iMWS. With the WPT, first modify the cable provided with the WPT. The cable modification is shown in *Table 37: Cable Modification for Kistler WPT* below.



Connect the female DB9 connector to the male ODO end of the iIMU-FSAS interface cable.

Table 37: Cable Modification for Kistler WPT

8-pin M12 connector on the Kistler cable ¹		Female DB9 connector
Pin 1	GND	External ²
Pin 2	+U _B (Input Power)	
Pin 3	Signal A	Pin 6
Pin 4	Signal A inverted	Pin 7
Pin 5	Signal B	Pin 3
Pin 6	Signal B inverted	Pin 1
Pin 7	Reserved	No change
Pin 8		



Kistler provides an M12 to DB9 cable for use with the WPT. However, certain revisions of this cable do not bring through all four signal inputs. The IMU-FSAS odometer interface requires all four signal inputs to operate correctly. See your WPT documentation for cable details.

¹This modification is for the Kistler WPT 8-pin M12-plug cable number 14865.

²The WPT requires power to operate, which is not supplied through the P4 connector on the IMU-FSAS interface cable. Pins 1 and 2 should therefore be connected to an external power supply (+10 to +30 VDC).

A.4 IMU-HG1900

The IMU-HG1900 contains a Honeywell HG1900 IMU.

Table 38: IMU-HG1900 Physical Specifications

Physical	
IMU Enclosure Size	130 mm x 130 mm x 125 mm
IMU Enclosure Weight	2.34 kg

See the following sections for more information about the IMU-HG1900.

- *IMU-HG1900 Mechanical Drawings* on the next page
- *IMU-HG1900 Sensor Specifications* on page 108
- *IMU-HG1900 Electrical and Environmental* on page 108
- *IMU-HG1900 Cables* on page 109

A.4.1 IMU-HG1900 Mechanical Drawings


 The dimensions in the following diagrams are in millimetres.

Figure 37: IMU-HG1900 Dimensions

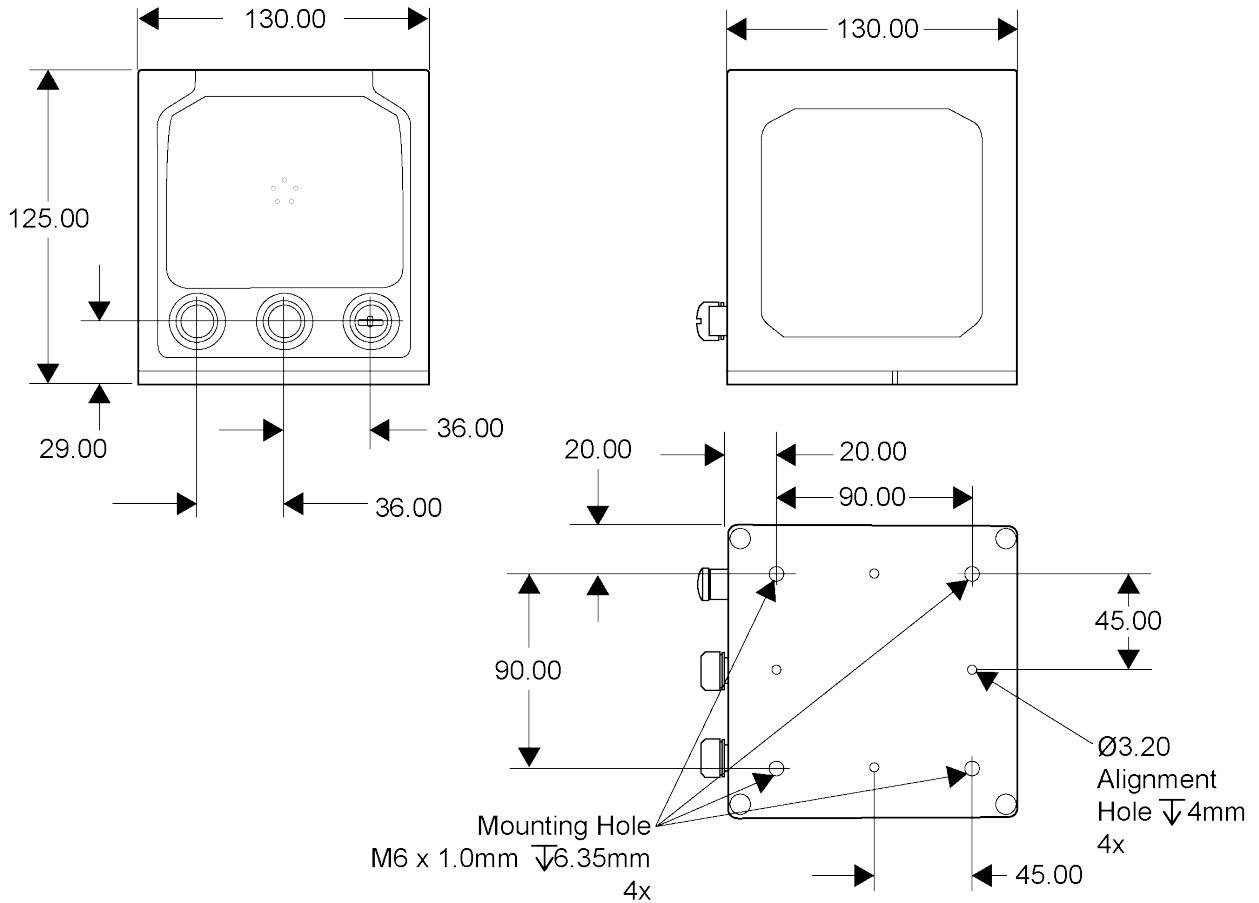
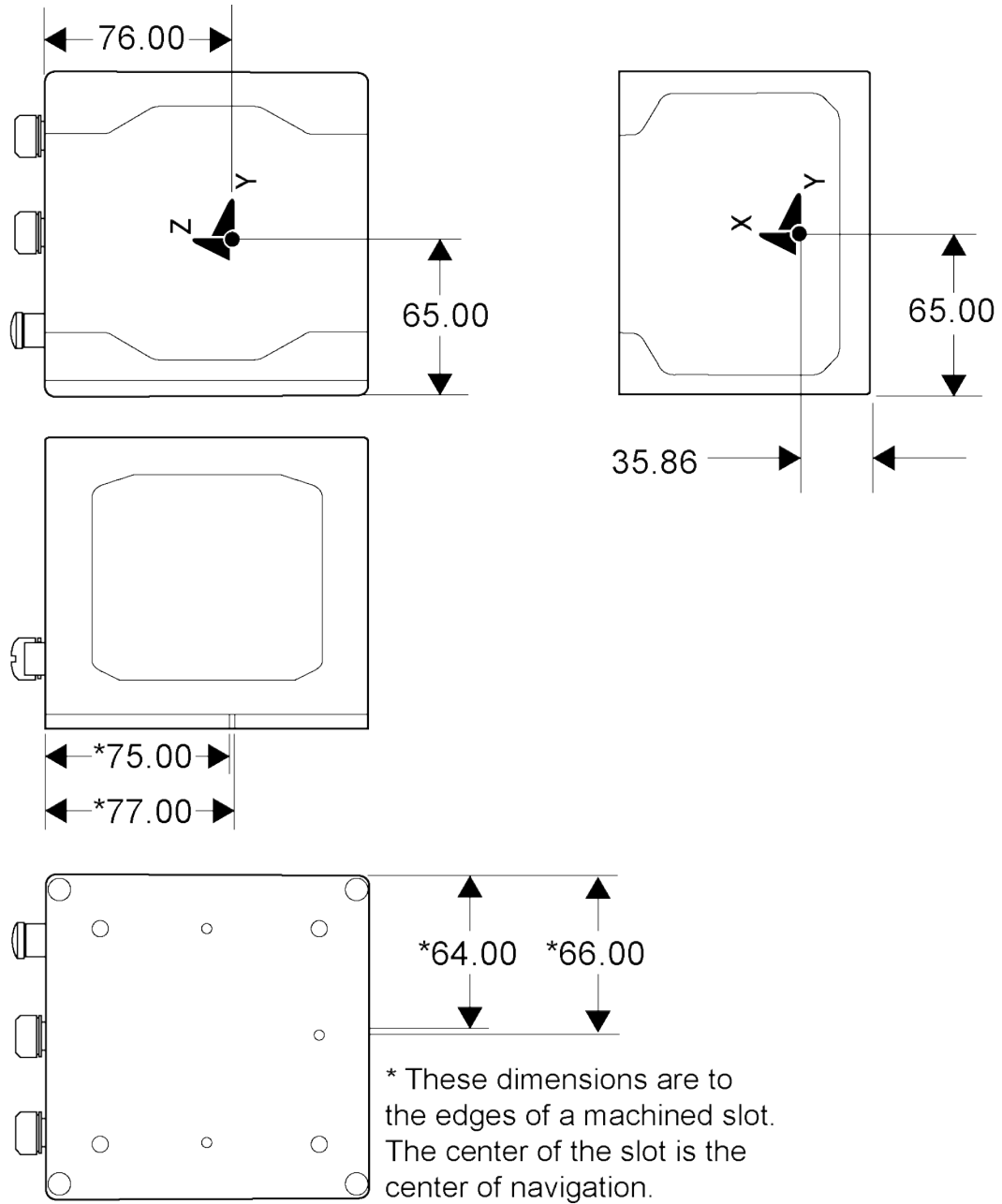


Figure 38: IMU-HG1900 Center of Navigation



A.4.2 IMU-HG1900 Sensor Specifications**Table 39: IMU-HG1900 IMU Performance**

Gyroscope Performance	
Input range	±1000 deg/sec
Rate bias	5 deg/hr
In-run bias stability	1 deg/hr
Rate Scale factor	150 ppm
Angular random walk	0.09 deg/√hr
Accelerometer Performance	
Range	±30 g
Linearity	500 ppm
Scale factor	300 ppm
Bias repeatability	1 mg
Bias in-run stability	0.7 mg
Data Rate	
IMU Measurement	100 Hz

A.4.3 IMU-HG1900 Electrical and Environmental**Table 40: IMU-HG1900 Electrical Specifications**

Electrical	
IMU Power Consumption	7.5 W (typical)
IMU Input Voltage	+10 to +34 V DC
IMU Interface	RS-422
Connectors	
Power	SAL M12, 5 pin, male
Data	SAL M12, 5 pin, female
Wheel Sensor	SAL M12, 8 pin, male

Table 41: IMU-HG1900 Environmental Specifications

Environmental	
Operating Temperature	-40°C to +55°C
Storage Temperature	-40°C to +80°C
Humidity	MIL-STD-810G, Method 507.5
Random Vibe	MIL-STD-810G. Method 514.6 (2.0 g)
Environment	IEC 60529 IP67

A.4.4 IMU-HG1900 Cables

IMU-HG1900 Interface Cable

The IMU-HG1900 uses the IMU Enclosure Interface Cable. Refer to *IMU Enclosure Interface Cable* on page 123 for details about this cable.

IMU-HG1900 Power Cable

The IMU-HG1900 uses the IMU Enclosure Power Cable. Refer to *IMU Enclosure Power Cable* on page 124 for details about this cable.

IMU-HG1900 Wheel Sensor Cable

The IMU-HG1900 uses the IMU Enclosure Wheel Sensor Cable. Refer to *IMU Enclosure Wheel Sensor Cable* on page 125 for details about this cable.

A.5 IMU-IGM

This section contains the specifications for both the IMU-IGM-A1 and IMU-IGM-S1.

Table 42: IMU-IGM-A1 Physical Specifications

Physical	
Enclosure Size	152.0 mm x 137.0 mm x 50.5 mm
Weight	475 g
Connectors	
MAIN	DB-15HD Female
AUX	DB-15HD Male

Table 43: IMU-IGM-S1 Physical Specifications

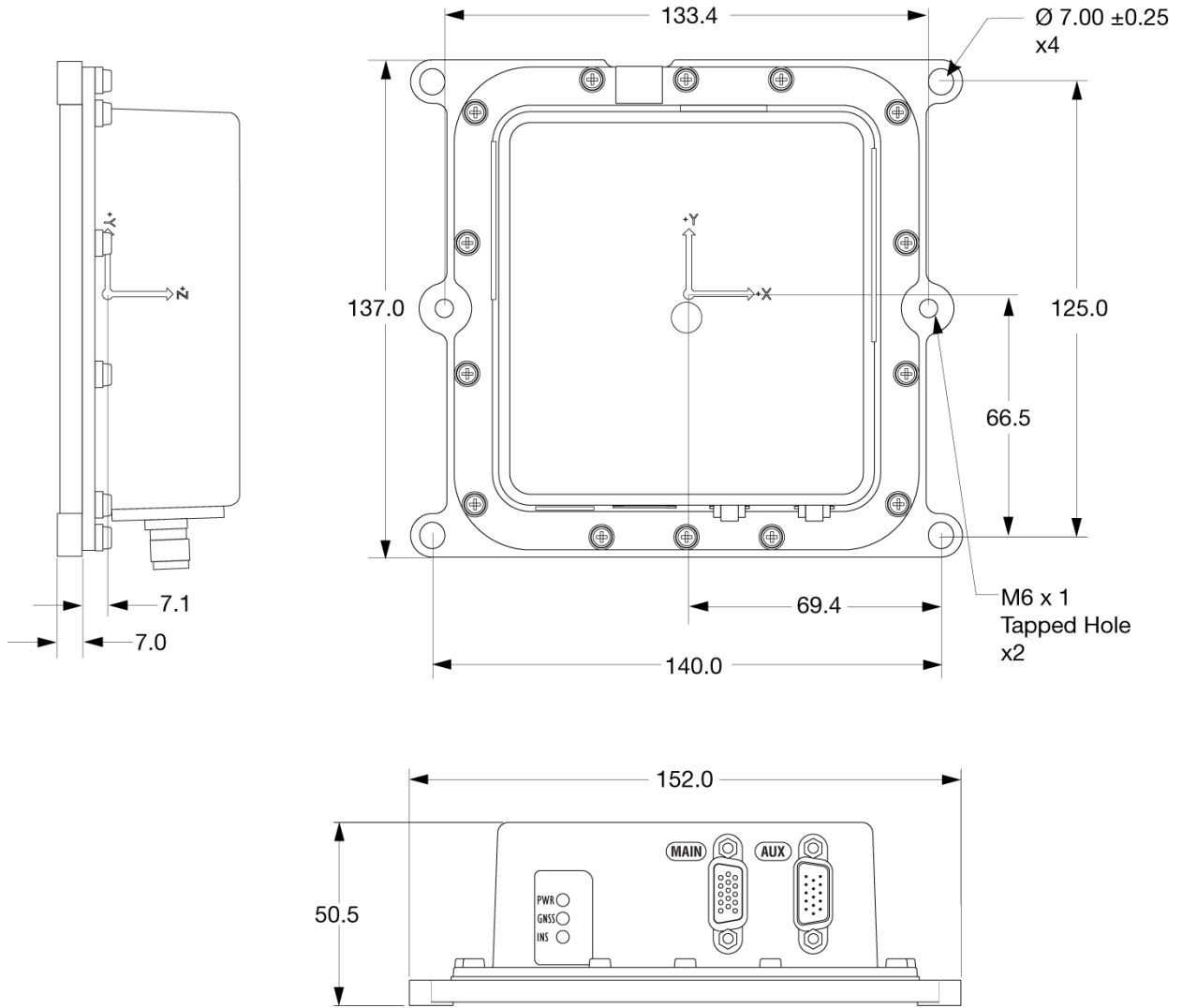
Physical	
Enclosure Size	152.0 mm x 137.0 mm x 50.5 mm
Weight	500 g
Connectors	
MAIN	DB-15HD Female
AUX	DB-15HD Male

See the following sections for more information about the IMU-IGM-A1 or IMU-IGM-S1 IMUs.

- *IMU-IGM Mechanical Drawings* on the next page
- *IMU-IGM Ports* on page 113
- *IMU-IGM Sensor Specifications* on page 114
- *IMU-IGM Electrical and Environmental* on page 115
- *IMU-IGM Interface Cable* on page 116

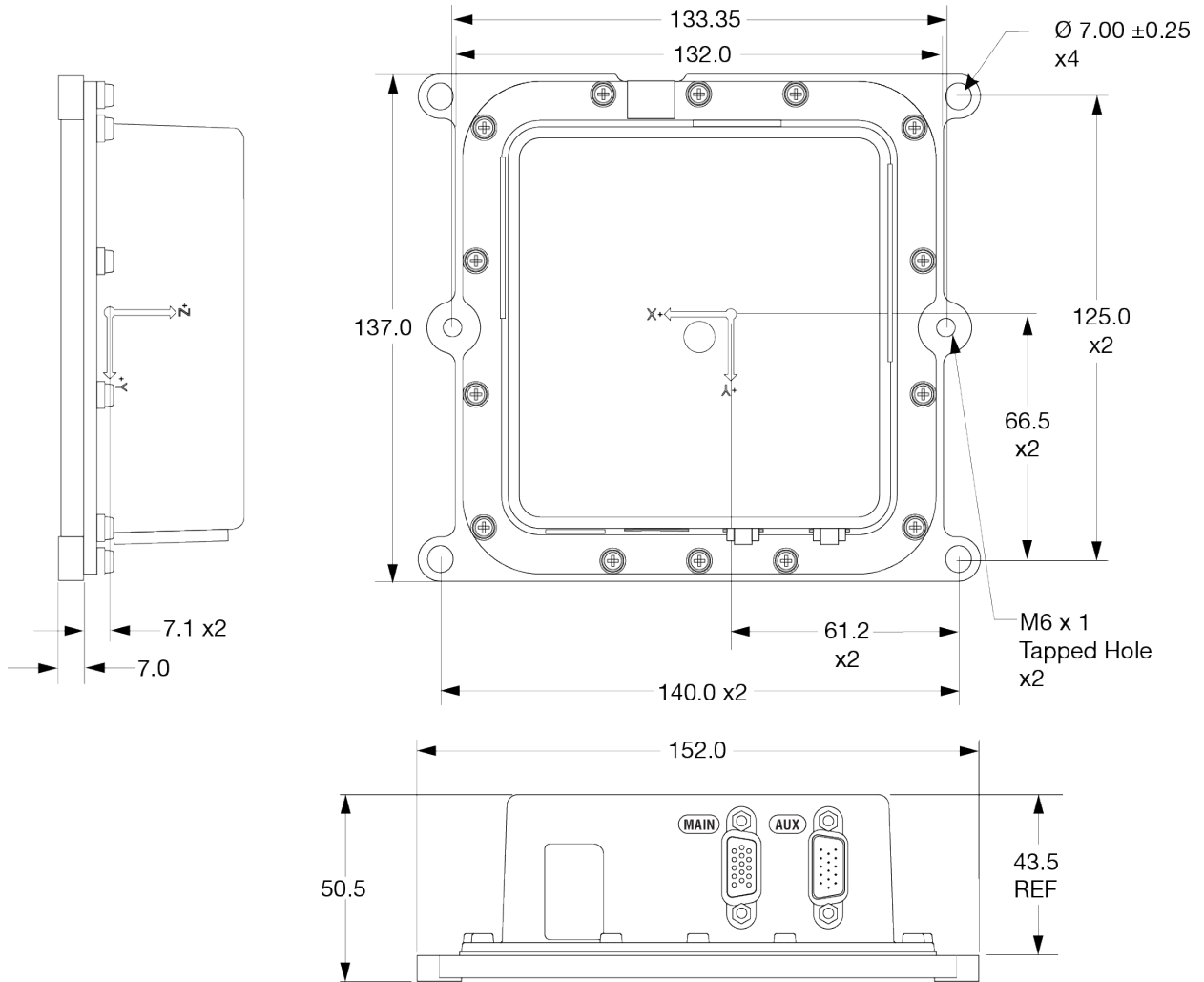
A.5.1 IMU-IGM Mechanical Drawings

Figure 39: IMU-IGM-A1 Dimensions



The center of navigation is at the location marked by the axis labels on the enclosure and indicated on the drawing above. It is not at the depression in the enclosure cover. The dimensions in the drawing are in millimetres.

Figure 40: IMU-IGM-S1 Dimensions



The center of navigation is at the location marked by the axis labels on the enclosure and indicated on the drawing above. It is not at the depression in the enclosure cover. The dimensions in the drawing are in millimetres.

A.5.2 IMU-IGM Ports**Table 44: IMU-IGM Main Port Pinout**

Pin #	Label	Description
1	MIC_TX/MIC_TX+	MODE2 high or open: MIC port transmit (RS-232) MODE2 low: MIC port transmit positive (RS-422)
2	MIC_TX-	MODE2 high or open: No connection MODE2 low: MIC port transmit negative (RS-422)
3	DGND	Digital ground
4	V+	IMU-IGM power supply input, positive
5	V-	IMU-IGM power supply input, negative
6	MIC_RX/MIC_RX+	MODE2 high or open: MIC port receiver (RS-232) MODE2 low: MIC port receive positive (RS-422)
7	MIC_RX-	MODE2 high or open: No connection MODE2 low: MIC port receive negative (RS-422)
8	DGND	Digital ground
9	Reserved	Reserved
10	Reserved	Reserved
11	DGND	Digital ground
12	Reserved	Reserved
13	MODE2	Mode 2 input, controls MIC port standard
14	Reserved	Reserved
15	Reserved	Reserved

Table 45: IMU-IGM AUX Port Pinout

Pin #	Label	Description
1	ODM_A+	Odometer input A positive
2	ODM_B+	Odometer input B positive (No connection on IMU-IGM-S1)
3	Reserved	Reserved

Pin #	Label	Description
4	WS_VOUT	Wheel sensor output voltage (12 VDC)
5	DGND	Digital ground
6	ODM_A-	Odometer input A negative
7	ODM_B-	Odometer input B negative (No connection on IMU-IGM-S1)
8	Reserved	Reserved
9	DGND	Digital ground
10	Reserved	Reserved
11	Reserved	Reserved
12	Reserved	Reserved
13	Reserved	Reserved
14	Reserved	Reserved
15	DGND	Digital ground

A.5.3 IMU-IGM Sensor Specifications

Table 46: IMU-IGM-A1 IMU Performance

Gyroscope Performance	
Gyro Input Range	± 450 °/second
In Run Gyro Rate Bias Stability	6.25 °/hour
Angular Random Walk	0.3 °/ $\sqrt{\text{hour}}$
Accelerometer Performance	
Accelerometer Range	± 18 g
In Run Accelerometer Bias Stability	0.1 mg
Velocity Random Walk	0.029 m/s/ $\sqrt{\text{hr}}$
Data Rate	
IMU Measurement	200 Hz

Table 47: IMU-IGM-S1 IMU Performance

Gyroscope Performance	
Gyro Input Range	± 400 °/second
In Run Gyro Rate Bias Stability	0.5 °/hour
Angular Random Walk	0.15 °/ $\sqrt{\text{hour}}$
Accelerometer Performance	
Accelerometer Range	± 10 g
In Run Accelerometer Bias Stability	0.05 mg
Velocity Random Walk	0.07 m/s/ $\sqrt{\text{hr}}$
Data Rate	
IMU Measurement	125 Hz

A.5.4 IMU-IGM Electrical and Environmental**Table 48: IMU-IGM-A1 Electrical Specifications**

Electrical	
Input Voltage	10 - 30 VDC
Power consumption	2.5 W (typical)

Table 49: IMU-IGM-A1 Environmental Specifications

Environmental	
Temperature, operational	-40°C to +65°C
Temperature, storage	-50°C to +80°C
Humidity	95% Non-condensing

Table 50: IMU-IGM-S1 Electrical Specifications

Electrical	
Input Voltage	10 - 30 VDC
Power consumption	<4.6 W (typical)

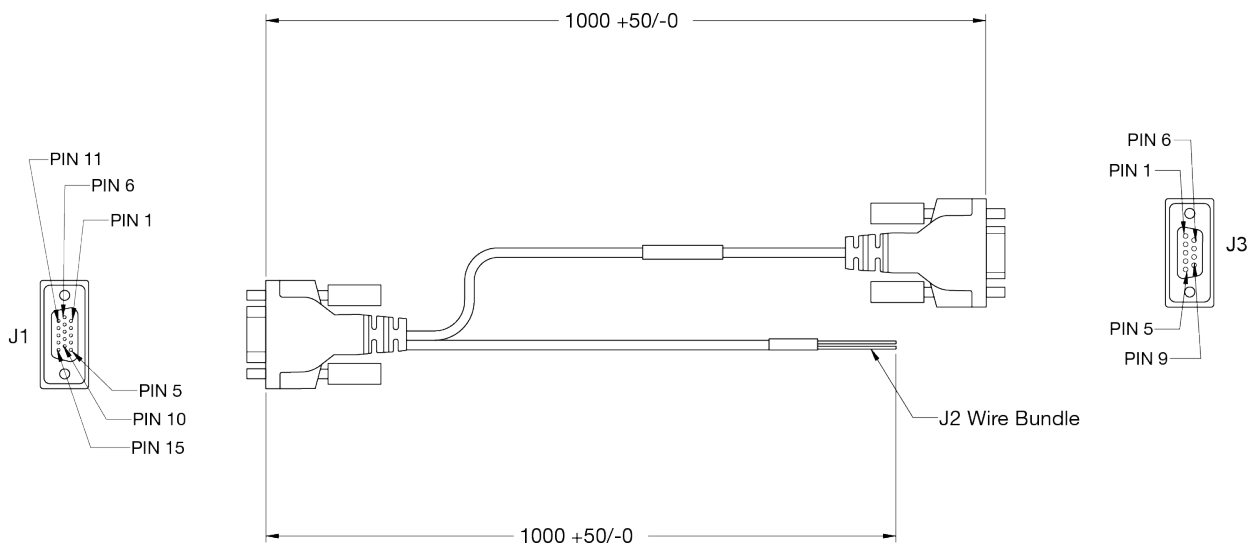
Table 51: IMU-IGM-S1 Environmental Specifications

Environmental	
Temperature, operational	-40°C to +65°C
Temperature, storage	-50°C to +80°C
Humidity	95% Non-condensing

A.5.5 IMU-IGM Interface Cable

The NovAtel part number for the IMU-IGM interface cable is 01019016. This cable provides power to the IMU-IGM and communication signals between the IMU-IGM and the OEM7 family receiver.

Figure 41: IMU-IGM Interface Cable




The dimensions in this drawing are in millimetres.

Table 52: IMU-IGM Interface Cable Pinout Descriptions

J1 MAIN Pin #	Function	J2 Wire Bundle Label	J3 MIC Port Pin #
1	MIC Port Transmit/Transmit+ (RS-422)		2
2	MIC Port Transmit- (RS-422)		8
3	Digital Ground		
4	Battery +	BATT+	

J1 MAIN Pin #	Function	J2 Wire Bundle Label	J3 MIC Port Pin #
5	Digital Ground	BATT-	
6	MIC Port Receive/Receive+ (RS-422)		3
7	MIC Port Receive- (RS-422)		7
8	Digital Ground		5
9	Reserved		
10	Reserved		
11	Digital Ground		
12	Reserved		
13	MODE 2	MODE 2	
14	Reserved		
15	Reserved		

 The MIC port can operate as either an RS-232 or RS-422 serial port.

- When the MODE 2 pin is left open or tied high, the MIC port operates as an RS-232 serial port.
- When the MODE 2 pin is tied low, the MIC port operates as an RS-422 serial port.

Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU-IGM interface cable (01019016).

Table 53: Connectors

Connector	Description
J1	DB-15HD, male
J2	DB-9, female

Table 54: Maximum Cable Length

IMU	RS-232	RS-422
IMU-IGM-A1, IMU-IGM-S1	< 1.2 metres	< 50 metres

A.6 IMU-ISA-100C

The IMU-ISA-100C contains an ISA-100C IMU.

Table 55: IMU-ISA-100C Physical Specifications

Physical	
IMU Enclosure Size	180 mm x 150 mm x 137 mm
IMU Enclosure Weight	5.0 kg

See the following sections for more information about the IMU-ISA-100C IMU.

- *IMU-ISA-100C Mechanical Drawings* on the next page
- *Optional Side Mounting Holes* on page 120
- *IMU-ISA-100C Performance* on page 122
- *IMU-ISA-100C Electrical and Environmental* on page 122
- *IMU Enclosure Interface Cable* on page 123
- *IMU Enclosure Power Cable* on page 124
- *IMU Enclosure Wheel Sensor Cable* on page 125

A.6.1 IMU-ISA-100C Mechanical Drawings


 The dimensions in the following diagrams are in millimetres.

Figure 42: IMU-ISA-100C Dimensions

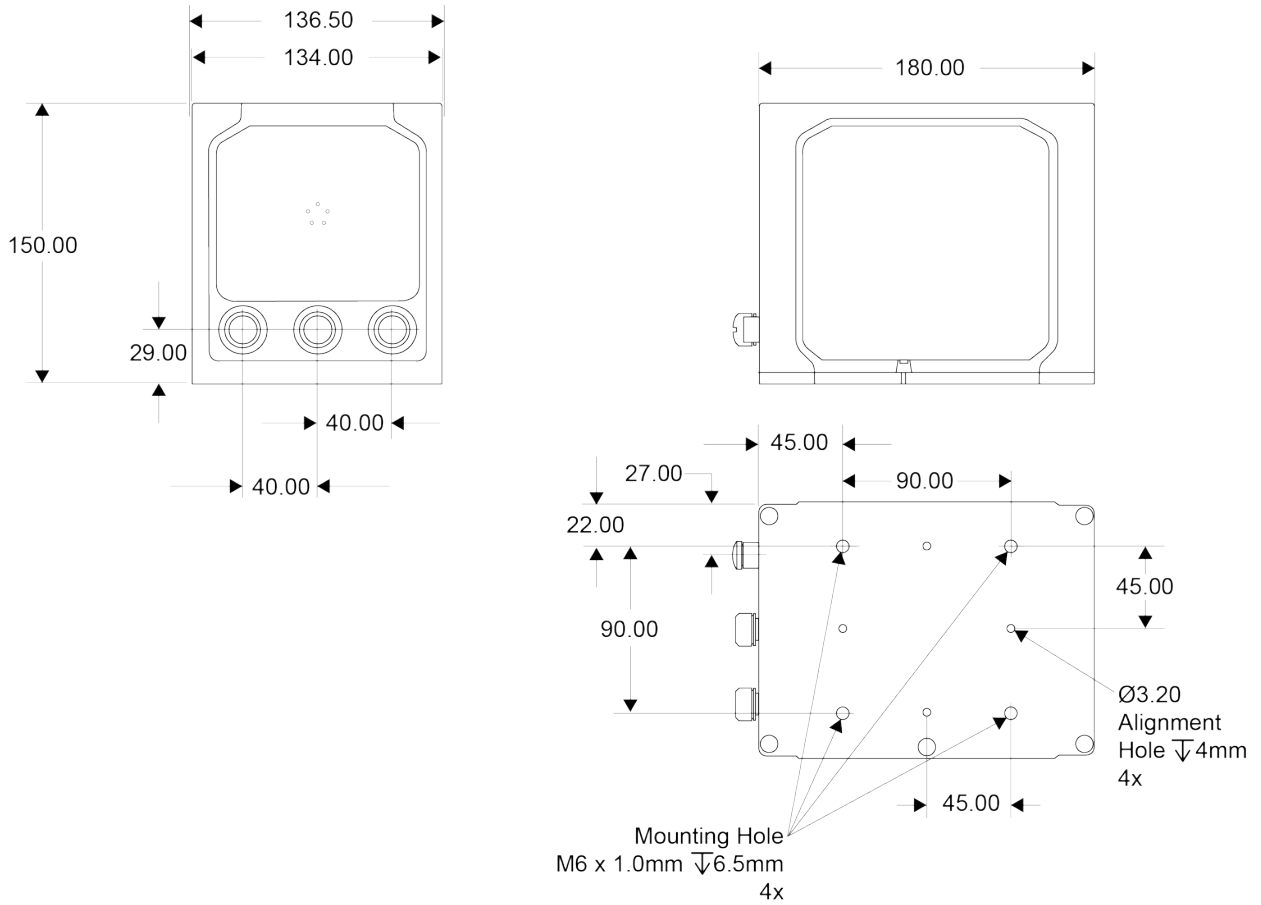
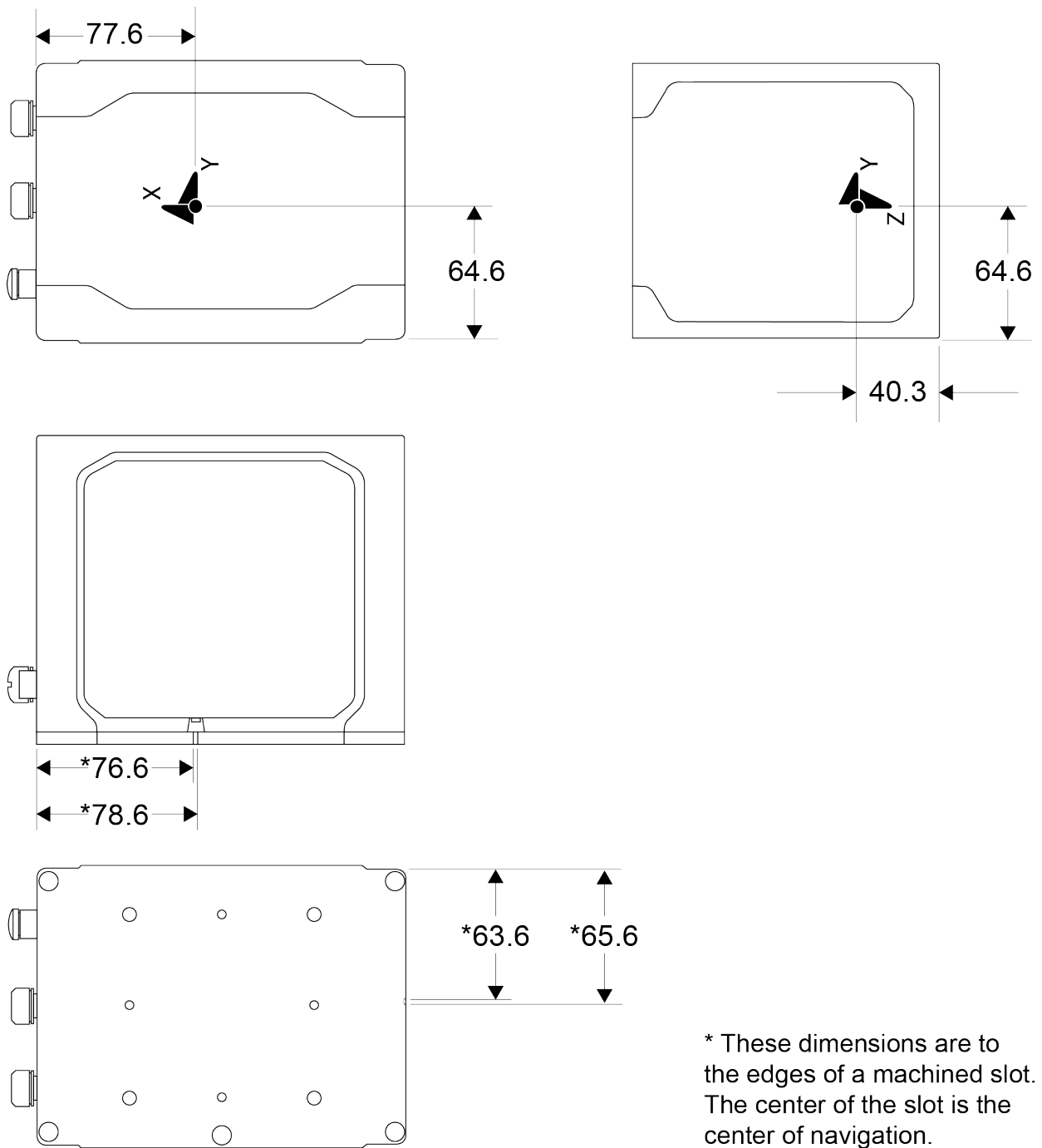


Figure 43: IMU-ISA-100C Center of Navigation

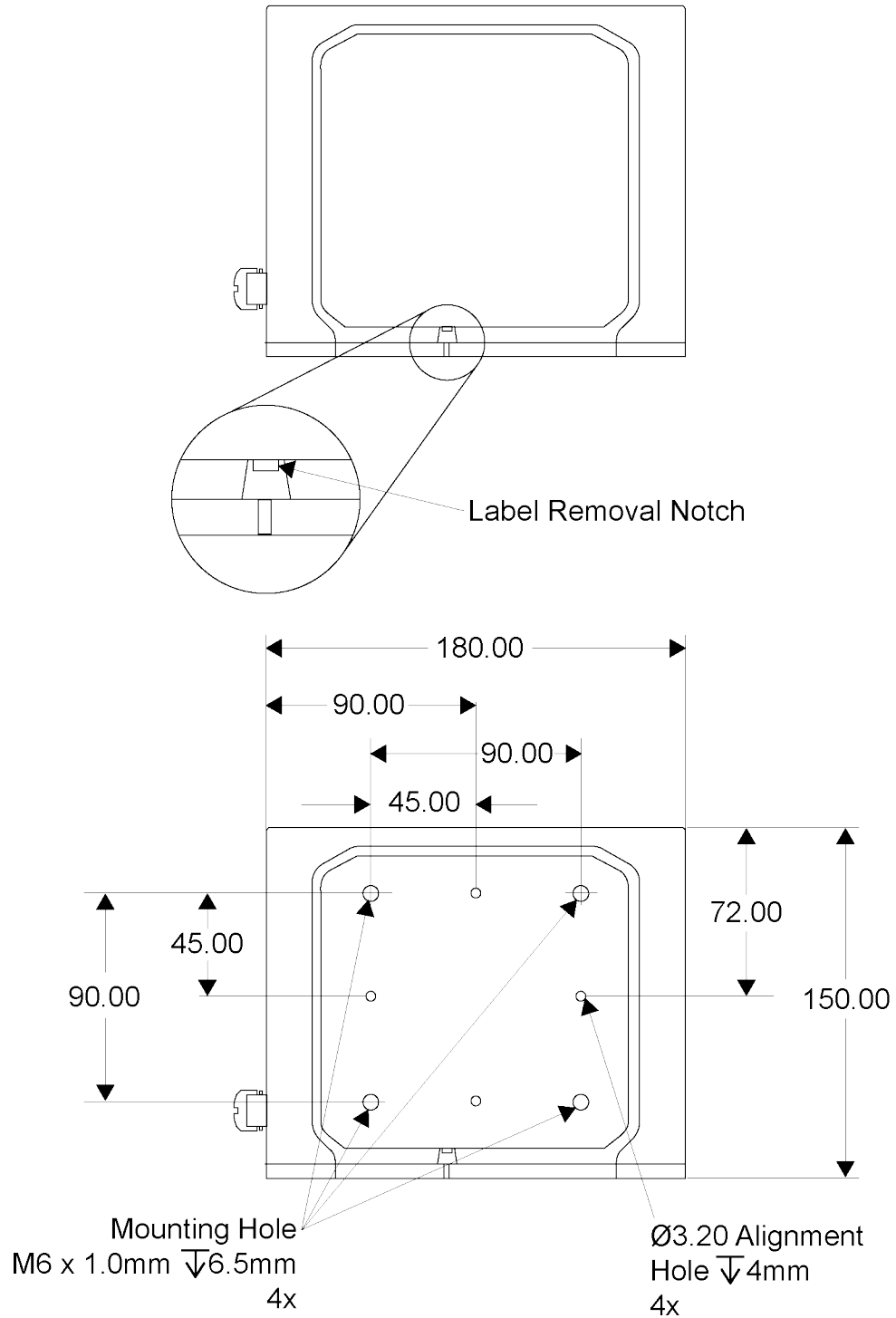


A.6.2 Optional Side Mounting Holes

There are mounting and alignment holes on both sides of the IMU enclosure to allow the IMU to be mounted on its side. These holes have the same pattern and spacing as the mounting and alignment holes on the bottom of the IMU enclosure.

To access these holes, the NovAtel label must be removed from the side of the enclosure. A small notch on the side of enclosure allows you to insert a small flat blade screw under the label to start lifting the label.

Figure 44: Optional Side Mounting Holes



A.6.3 IMU-ISA-100C Performance**Table 56: IMU-ISA-100C IMU Performance**

Gyroscope Performance	
Input range	±495 deg/sec
In-run bias stability	≤0.05 deg/hr
Scale factor repeatability	≤100 ppm
Scale factor non-linearity	≤100 ppm
Angular random walk	0.012 deg/√hr
Accelerometer Performance	
Range	±10 g
In-run bias stability	≤100 μg
1 year scale factor repeatability	≥1250 μg
Scale factor non-linearity	≤100 ppm
Velocity random walk	≤100 μg/√Hz
Data Rate	
IMU Measurement	200 Hz

A.6.4 IMU-ISA-100C Electrical and Environmental**Table 57: IMU-ISA-100C Electrical Specifications**

Electrical	
IMU Power Consumption	18 W (typical)
IMU Input Voltage	+10 to +34 V DC
IMU Interface	RS-422
Connectors	
Power	SAL M12, 5 pin, male
Data	SAL M12, 5 pin, female
Wheel Sensor	SAL M12, 8 pin, male

Table 58: IMU-ISA-100C Environmental Specifications

Environmental	
Operating Temperature	-40°C to +55°C
Storage Temperature	-40°C to +85°C
Humidity	MIL-STD-810G, Method 507.5
Water Ingress	MIL-STD-810G. Method 512.5

A.6.5 IMU Enclosure Interface Cable

The NovAtel part number for the IMU Enclosure interface cable is 01019319 (see *Figure 45: IMU Enclosure Interface Cable* below). This cable enables communication between the receiver and the IMU.


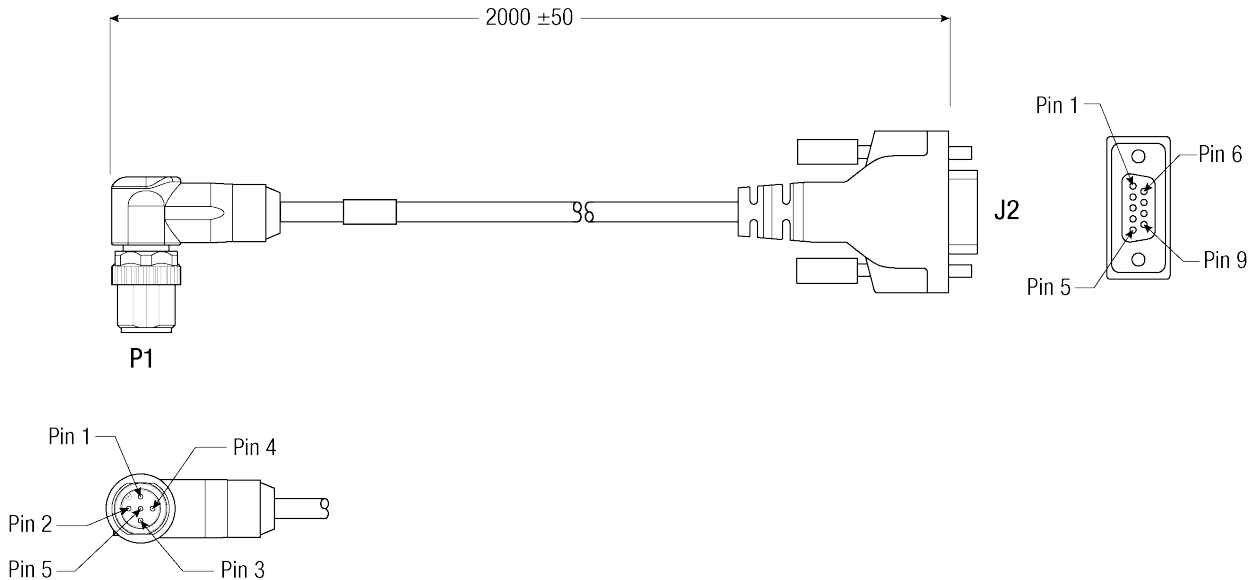
 This cable is used for all versions of the IMU Enclosure (IMU-ISA-100C, IMU-LN200, IMU-HG1900 and IMU-μIMU).

Figure 45: IMU Enclosure Interface Cable



 Dimensions are in millimetres.

Table 59: IMU Enclosure Interface Cable Pinouts

P1 Pinout (M12)	Function	J2 Pinout (DB9)
1	TX+	2

P1 Pinout (M12)	Function	J2 Pinout (DB9)
2	RX+	3
3	TX-	8
4	RX-	7
5	GND	5
Shield	Shield	Shield

Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU Enclosure interface cable (01019319).

Table 60: Connectors

Connector	Description
P1	M12x1, 5 position, male
J2	DB-9, female

Table 61: Maximum Cable Length

IMU	RS-422
IMU-ISA-100C	< 50 metres

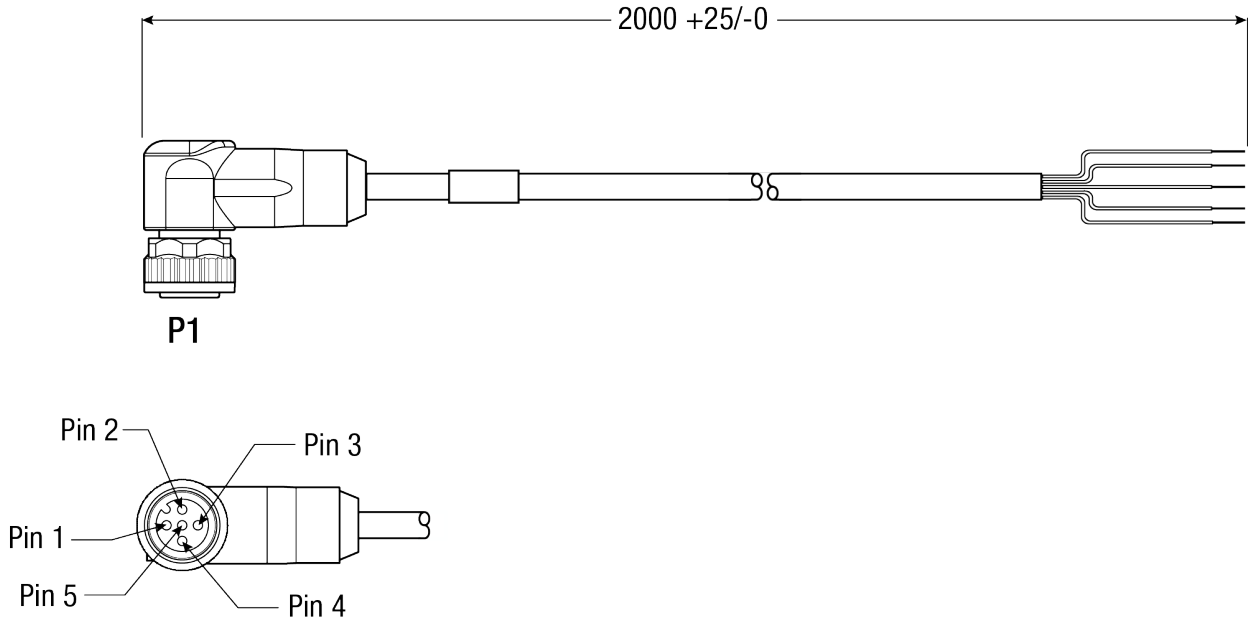
A.6.6 IMU Enclosure Power Cable

The NovAtel part number for the IMU Enclosure power cable is 60723136 (see *Figure 46: IMU Enclosure Power Cable* on the next page). This cable provides power to the IMU from an external power source.



This cable is used for all versions of the IMU Enclosure (IMU-ISA-100C, IMU-LN200, IMU-HG1900 and IMU- μ IMU).

Figure 46: IMU Enclosure Power Cable



i Dimensions are in millimetres.

Table 62: IMU Enclosure Power Cable Pinouts

P1 Pinout (M12)	Function	Bare Wire Color
1	VIN-	Brown
2	VIN+	White
3	VIN+	Blue
4	VIN-	Black
5	Chassis Ground	Grey

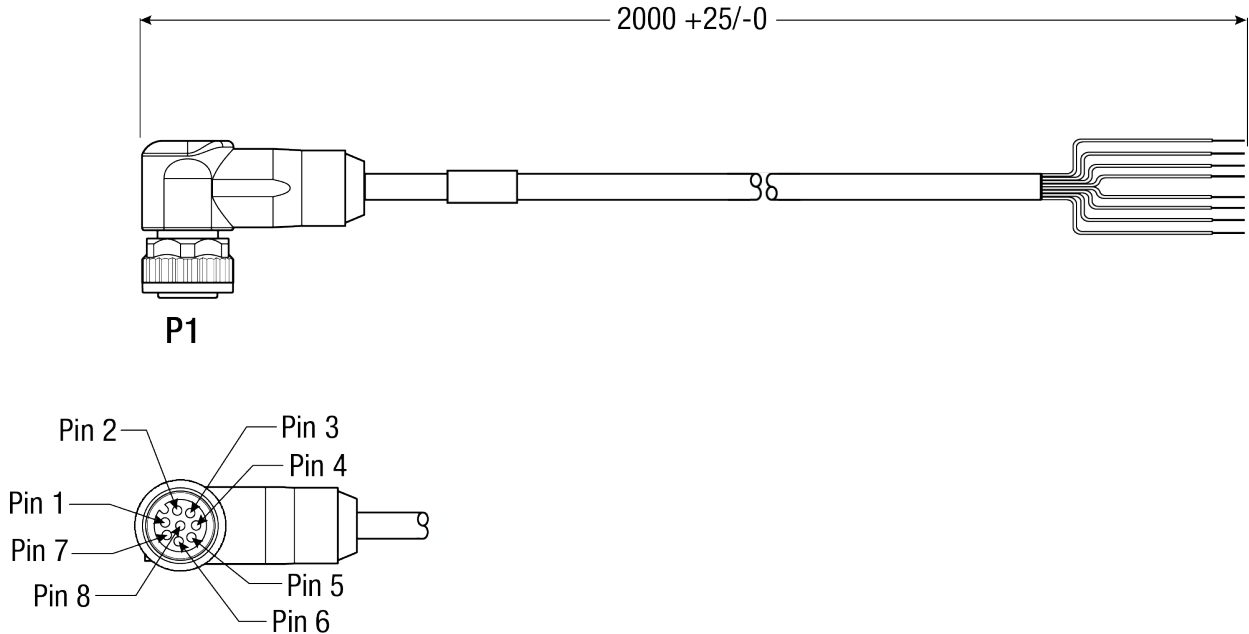
i This cable uses a M12x1, 5 position, female connector.

A.6.7 IMU Enclosure Wheel Sensor Cable

The NovAtel part number for the IMU Enclosure wheel sensor cable is 60723137 (see *Figure 47: IMU Enclosure Wheel Sensor Cable* on the next page). This cable enables communication between the IMU and the wheel sensor.

i This cable is used for all versions of the IMU Enclosure (IMU-ISA-100C, IMU-LN200, IMU-HG1900 and IMU-μIMU).

Figure 47: IMU Enclosure Wheel Sensor Cable



Dimensions are in millimetres.

Table 63: IMU Enclosure Wheel Sensor Cable Pinouts

P1 Pinout (M12)	Function	Bare Wire Color
1	A+	White
2	B+	Brown
3	Chassis Ground	Green
4	A-	Yellow
5	B-	Grey
6	Chassis Ground	Pink
7	Reserved	Blue
8	Reserved	Red

Wheel Sensors

The wheel sensor cable provides wheel sensor input from the Distance Measurement Instrument (DMI) to the IMU. The DMI data goes through the IMU and then into the SPAN receiver through the serial communication line.

One of the wheel sensors compatible with the IMU-ISA-100C is the Kistler Wheel Pulse Transducer CWPTA411 (WPT). See *Figure 48: Kistler WPT* on the next page.

- A transducer traditionally fits to the outside of a non-drive wheel. A pulse is then generated from the transducer which is fed directly to the IMU cable.
- The WPT mounts to the wheel lug nuts via adjustable mounting collets. The torsion protection rod, which maintains rotation around the wheel axis, affixes to the vehicle body with suction cups. Refer to the Kistler WPT (part number CWPTA411) user manual for mounting instructions.

Figure 48: Kistler WPT



The DMI runs only one output line (A).



SPAN specifies that the maximum pulse frequency for a wheel sensor input to SPAN is 1 MHz.

Table 64: *Kistler to NovAtel Wheel Sensor Cable Connections* below shows connections required between the Kistler cable and the IMU-ISA-100C wheel sensor cable.


Table 64: Kistler to NovAtel Wheel Sensor Cable Connections

M12 Connector on Kistler Cable		Signal	M12 Connector on NovAtel Cable	
Pin			Pin	Bare Wire Color
1	GND	External ²		
2	+U _B (Input Power)			
3	Signal A	1	White	

¹This modification is for the Kistler WPT 8-pin M12-plug cable number 14865.

²The WPT requires power to operate, which is not supplied through the P1 connector on the IMU-ISA-100C interface cable. Pins 1 and 2 should therefore be connected to an external power supply (+10 to +30 VDC).

M12 Connector on Kistler Cable		Signal	M12 Connector on NovAtel Cable	
Pin			Pin	Bare Wire Color
4		Signal A Inverted	4	Yellow
5		Signal B	2	Brown
6		Signal B Inverted	5	Grey
7	Reserved		No Connection	
8				

 Kistler provides an M12 to DB9 cable for use with the WPT. However, certain revisions of this cable do not bring through all four signal inputs. The odometer interface requires all four signal inputs to operate correctly. See your WPT documentation for cable details.

Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU-ISA-100C Wheel Sensor cable (60723137).

Table 65: Connectors

Connector	Description
P1	M12x1, 8 position, female
J2	DB-9, female

Table 66: Maximum Cable Length

IMU	RS-422
IMU-ISA-100C	< 50 metres

¹This modification is for the Kistler WPT 8-pin M12-plug cable number 14865.

A.7 IMU-KVH1750 / IMU-KVH1725

Table 67: IMU-KVH1750 / IMU-KVH1725 Physical Specifications

Physical	
Enclosure Size	88.9 mm X 73.7 mm
Weight	<0.7 kg

See the following sections for more information about the IMU-KVH-1750 and IMU-KVH1725.

- *IMU-KVH1750 / IMU-KVH1725 Mechanical Drawings* on the next page
- *IMU-KVH1750 / IMU-KVH1725 Sensor Specifications* on page 134
- *IMU-KVH1750 / IMU-KVH1725 Electrical and Environmental* on page 135
- *IMU-KVH1750 / IMU-KVH1725 Cable* on page 136

A.7.1 IMU-KVH1750 / IMU-KVH1725 Mechanical Drawings


 The dimensions in the following diagrams are in millimetres.

Figure 49: IMU-KVH1750 / IMU-KVH1725 Bottom view

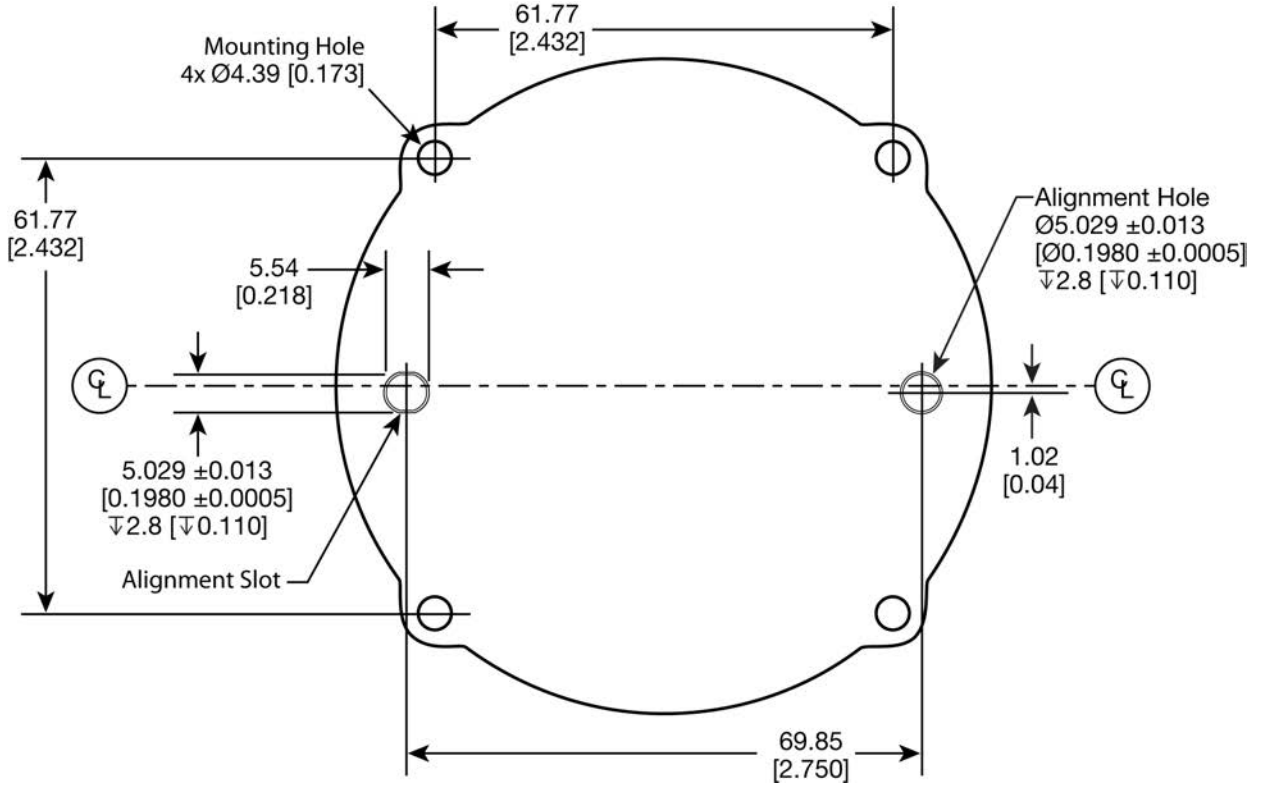


Figure 50: IMU-KVH1750 / IMU-KVH1725 Top View

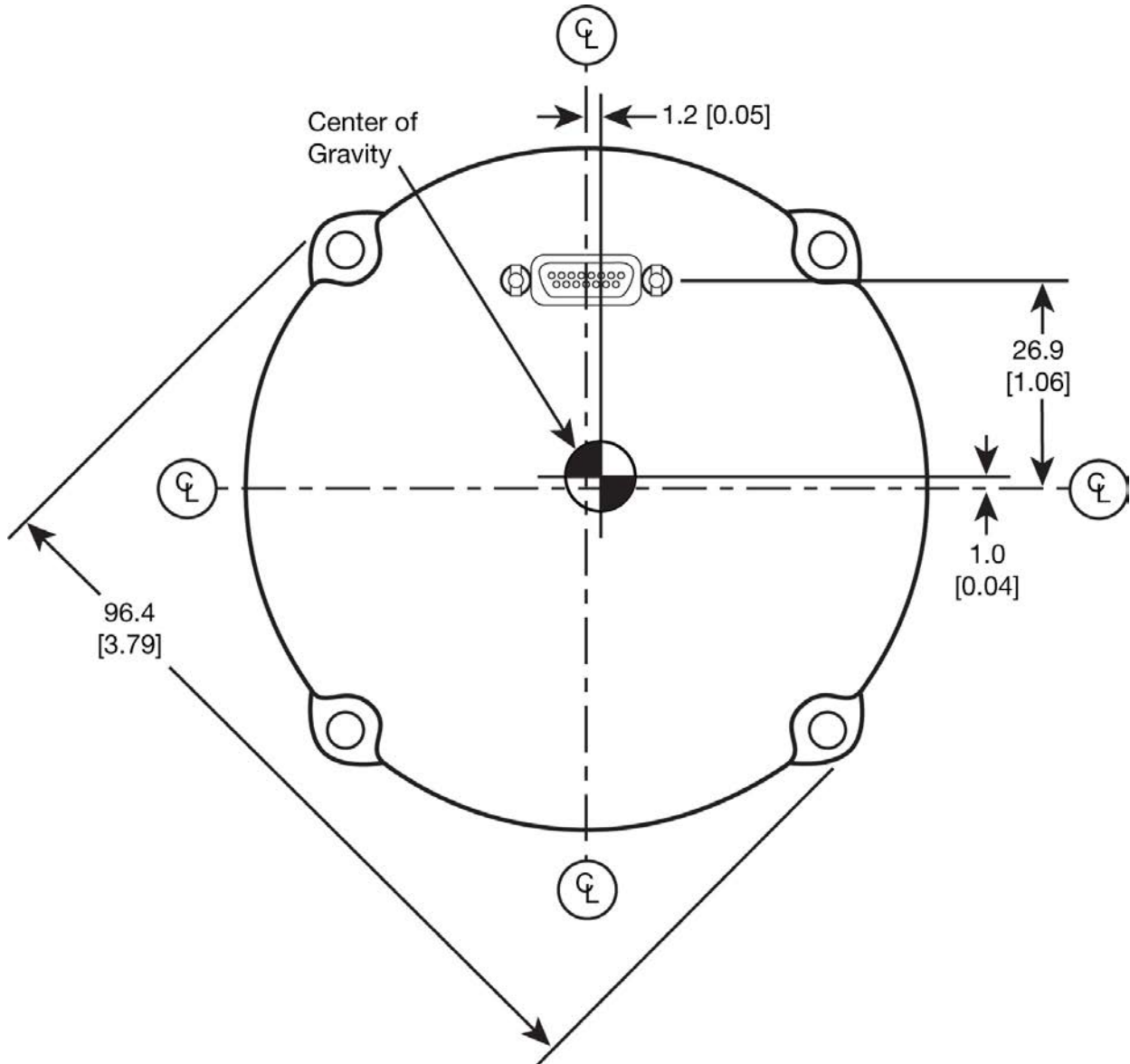


Figure 51: IMU-KVH1750 / IMU-KVH1725 Side View

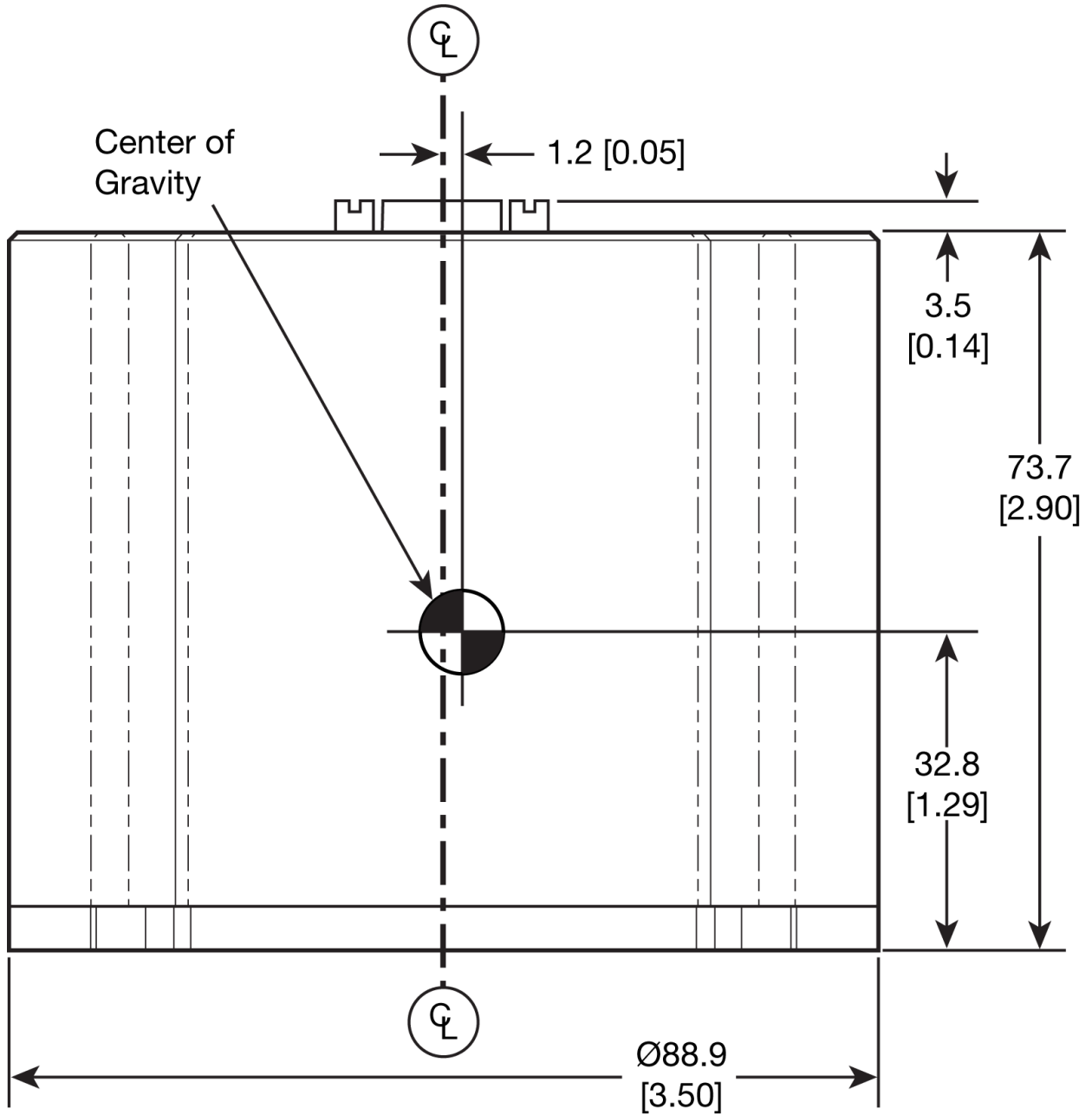
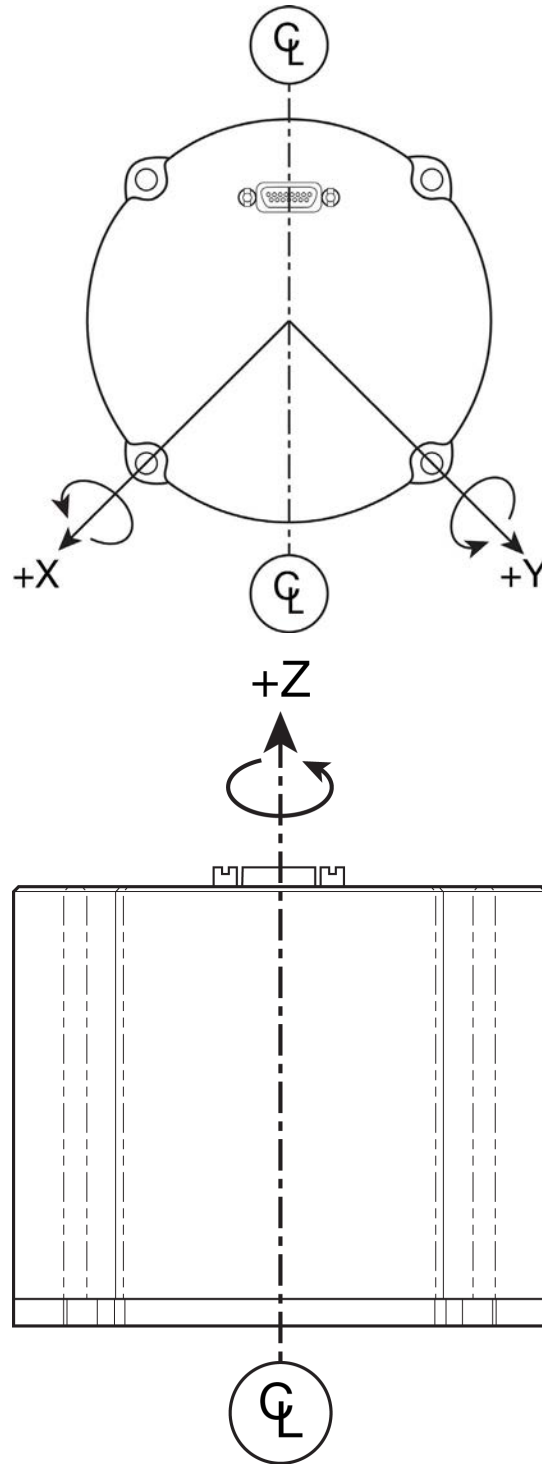


Figure 52: IMU-KVH1750 / IMU-KVH1725 Gyro Axes



A.7.2 IMU-KVH1750 / IMU-KVH1725 Sensor Specifications**Table 68: IMU-KVH1750 Performance**

Gyroscope Performance	
Maximum Input Rate	± 490 °/second
Bias Stability (constant temperature)	0.05°/hr (typical) 0.1°/hr (max)
Bias Temperature Sensitivity (full temp.)	0.7°/hr (typical) 1°/hr (max)
Bias Offset (at 25° C)	± 2 °/hr
Scale Factor (nominal)	$1 \pm 0.2\%$
Scale Factor Non-linearity (at 25° C)	≤ 50 ppm
Scale Factor Temperature Sensitivity	≤ 200 ppm
Angular Random Walk	≤ 0.012 °/ $\sqrt{\text{hr}}$
Input Axis Misalignment	± 0.4 mrad
Accelerometer Performance	
Maximum Input	± 10 g
Bias Stability (at 25° C)	≤ 0.05 mg
Scale Factor Temperature Sensitivity	≤ 100 ppm/°C (typical) 250 ppm/°C (max)
Velocity Random Walk	0.12 mg/ $\sqrt{\text{Hz}}$
Input Axis Misalignment	± 1.0 mrad
Data Rate	
IMU Measurement	200 Hz

Table 69: IMU-KVH1725 Performance

Gyroscope Performance	
Maximum Input Rate	± 490 °/second
Bias Stability (constant temperature)	≤ 0.1 °/hr
Bias Temperature Sensitivity (full temp.)	≤ 4 °/hr (max)
Bias Offset (at 25° C)	± 5 °/hr

Scale Factor (nominal)	1 ±0.2%
Scale Factor Non-linearity (at 25° C)	≤200 ppm
Scale Factor Temperature Sensitivity	≤300 ppm
Angular Random Walk	≤0.017 °/√hr
Input Axis Misalignment	±0.4 mrad
Accelerometer Performance	
Maximum Input	±10 g
Bias Stability (at 25° C)	≤0.1 mg
Scale Factor Temperature Sensitivity	≤100 ppm/°C (typical) 250 ppm/°C (max)
Velocity Random Walk	≤0.12 mg/√Hz
Input Axis Misalignment	±1.0 mrad
Data Rate	
IMU Measurement	200 Hz

A.7.3 IMU-KVH1750 / IMU-KVH1725 Electrical and Environmental

Table 70: IMU-KVH1750 / IMU-KVH1725 Electrical and Environmental Specifications

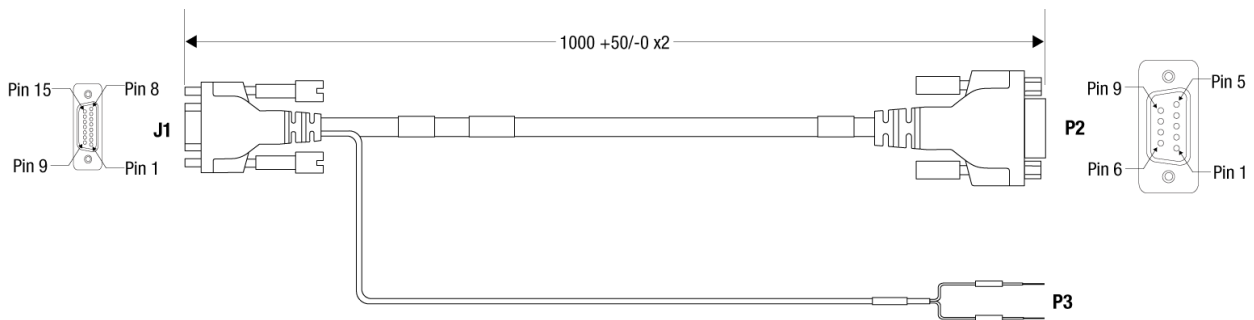
Connectors	
Power and I/O	15-pin Micro-D (male)
Electrical	
Input Voltage	9 - 36 VDC
Power Consumption	5W (typical), 8W (max)
Turn-On Time (room temp.)	≤1.25 seconds
Full Performance Time (room temp.)	≤60 seconds
IMU Interface	RS-422
Environmental	
Temperature, operational	-40°C to +75°C
Temperature, non-operational	-50°C to +85°C
Vibration, operational	8 g rms, 20 Hz -2 kHz

Vibration, non-operational	12 g rms, 20 Hz -2 kHz
Shock, operational	9 g (11 ms, sawtooth)
Shock, non-operational	40 g (11 ms, sawtooth)

A.7.4 IMU-KVH1750 / IMU-KVH1725 Cable

The NovAtel part number for the IMU-KVH1750 / IMU-KVH1725 cable is 01019211. This cable provides power to the IMU from an external power source and enables communication between the receiver and the IMU.

Figure 53: IMU-KVH1750 / IMU-KVH1725 Cable



Dimensions are in millimetres.

Table 71: IMU-KVH1750 / IMU-KVH1725 Connector Pinout Descriptions

J1 (15 Pin Micro D Female)		P2 (Female DB9)		P3
Pin #	Signal Name	Pin #	Signal Name	Labels
1	TX+	2	RX+	
2	TX-	8	RX-	
3	RX-	7	TX-	
4	RX+	3	TX+	
5	Reserved			
6	Reserved			
7	Reserved			
8	Reserved			
9	Power Return			PWR-
10	VDC Power			PWR+

J1 (15 Pin Micro D Female)		P2 (Female DB9)		P3
Pin #	Signal Name	Pin #	Signal Name	Labels
11	MSync	1	IMU Event Out (Sync)	
12	TOV-Out	9	Event In	
13	Reserved			
14	Reserved			
15	Signal Ground	5	Signal Ground	
Shell	Chassis Ground	Shell	Chassis Ground	



A hardware change by KVH regarding KVH1750 IMUs (manufactured after November 2015) expect a differential MSYNC signal input (J1 (15 pin micro D female) of the IMU: Pin 11 MSync+, Pin 7 MSync-). This was previously a single ended input signal on Pin 11 only. The NovAtel VARF signal used to provide the MSYNC to the IMU remains single ended, however significant testing has been completed with the existing IMU-KVH1750 Cable (01019211) in safe environments (no interference sources). No issues or failures have been observed. There are no plans to modify NovAtel cables at this time. However, for any custom or OEM cable solutions, it is recommended to follow KVH guidelines in providing a differential MSYNC signal, converting the VARF to differential and properly shielding for optimal reliability.

Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU-KVH1750 / IMU-KVH1725 cable (01019211).

Table 72: Connectors

Connector	Description
J1	Micro-D, 15-pin, female
J2	DB-9, female

Table 73: Maximum Cable Length

IMU	RS-422
IMU-KVH1750	< 1.5 metres

A.8 IMU-LN200

The IMU-LN200 contains an LN200 or LN200C IMU.

Table 74: IMU-LN200 Physical Specifications

Physical	
IMU Enclosure Size	150 mm x 134 mm x 134 mm
IMU Enclosure Weight	<3.4 kg

See the following sections for more information about the IMU-LN200.

- *IMU-LN200 Mechanical Drawings* on the next page
- *IMU-LN200 Sensor Specifications* on page 141
- *IMU-LN200 Electrical and Environmental* on page 142
- *IMU-LN200 Cables* on page 142

A.8.1 IMU-LN200 Mechanical Drawings


 The dimensions in the following diagrams are in millimetres.

Figure 54: IMU-LN200 Dimensions

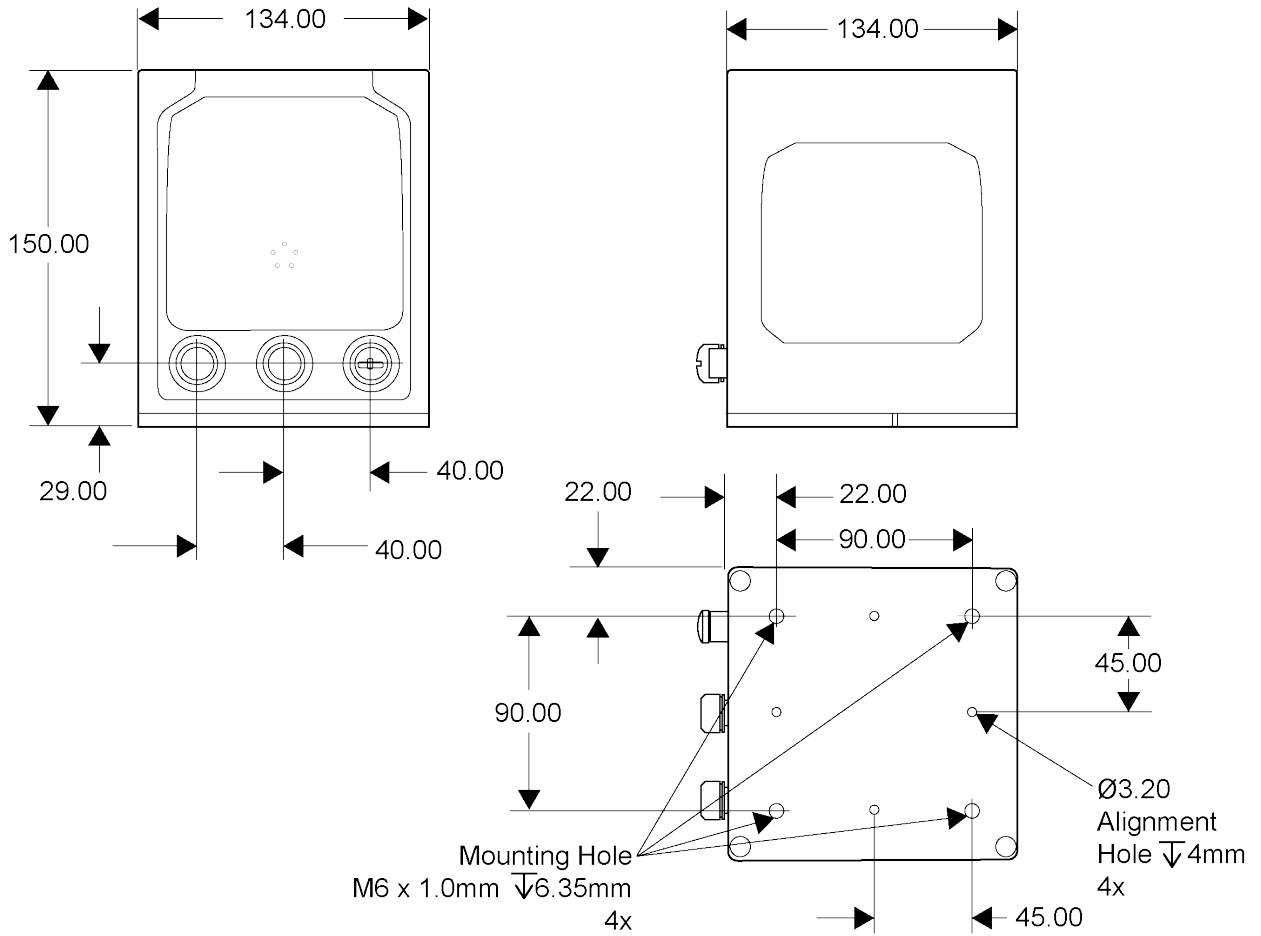
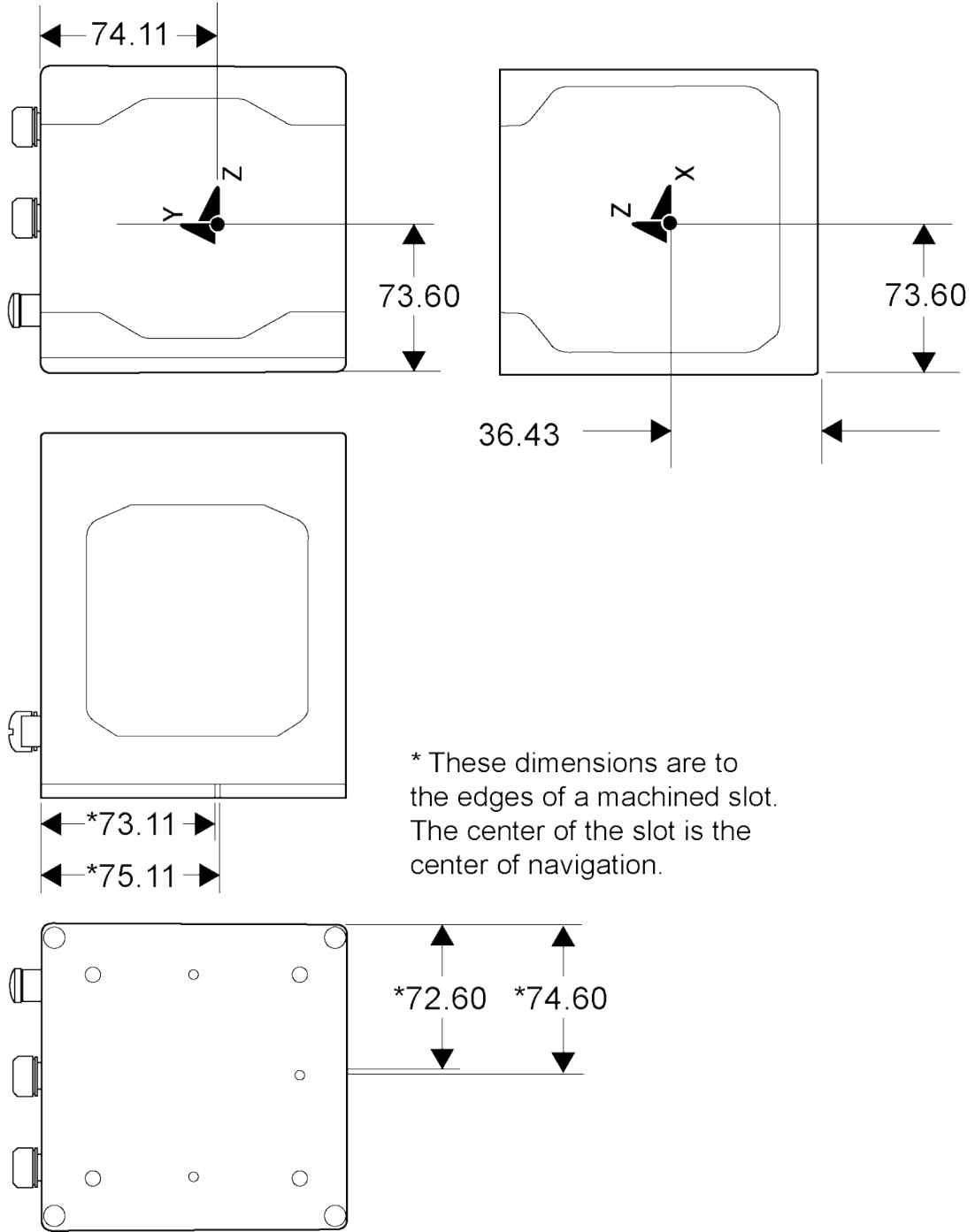


Figure 55: IMU-LN200 Center of Navigation



A.8.2 IMU-LN200 Sensor Specifications**Table 75: IMU-LN200 IMU Performance**

Gyroscope Performance	
Input range	± 1000 deg/sec
Rate bias	1.0 deg/hr
Scale factor error	100 ppm
Angular random walk	0.07 deg/ $\sqrt{\text{hr}}$
Accelerometer Performance	
Input range	± 40 g
Scale factor asymmetry	150 ppm
Scale factor error	300 ppm
Bias	0.3 mg
Data Rate	
IMU Measurement	200 Hz

Table 76: IMU-LN200C IMU Performance

Gyroscope Performance	
Input range	± 490 deg/sec
Rate bias	1.0 deg/hr
Scale factor error	100 ppm
Angular random walk	0.07 deg/ $\sqrt{\text{hr}}$
Accelerometer Performance	
Input range	± 15 g
Scale factor asymmetry	150 ppm
Scale factor error	300 ppm
Bias	1.0 mg
Data Rate	
IMU Measurement	200 Hz

A.8.3 IMU-LN200 Electrical and Environmental

Table 77: IMU-LN200 Electrical Specifications

Electrical	
IMU Power Consumption	14 W (typical)
IMU Input Voltage	+10 to +34 V DC
IMU Interface	RS-422
Connectors	
Power	SAL M12, 5 pin, male
Data	SAL M12, 5 pin, female
Wheel Sensor	SAL M12, 8 pin, male

Table 78: IMU-LN200 Environmental Specifications

Environmental	
Operating Temperature	-40°C to +55°C
Storage Temperature	-40°C to +80°C
Humidity	MIL-STD-810G, Method 507.5
Random Vibe	MIL-STD-810G. Method 514.6 (2.0 g)
Environment	IEC 60529 IP67

A.8.4 IMU-LN200 Cables

IMU-LN200 Interface Cable

The IMU-LN200 uses the IMU Enclosure Interface Cable. Refer to *IMU Enclosure Interface Cable* on page 123 for details about this cable.

IMU-LN200 Power Cable

The IMU-LN200 uses the IMU Enclosure Power Cable. Refer to *IMU Enclosure Power Cable* on page 124 for details about this cable.

IMU-LN200 Wheel Sensor Cable

The IMU-LN200 uses the IMU Enclosure Wheel Sensor Cable. Refer to *IMU Enclosure Wheel Sensor Cable* on page 125 for details about this cable.

A.9 IMU- μ IMU

The IMU- μ IMU contains a Litef μ IMU.

Table 79: IMU- μ IMU Physical Specifications

Physical	
IMU Enclosure Size	130 mm x 130 mm x 115 mm
IMU Enclosure Weight	2.57 kg

See the following sections for more information about the IMU- μ IMU.

- *IMU- μ IMU Mechanical Drawings* on the next page
- *IMU- μ IMU Sensor Specifications* on page 146
- *IMU- μ IMU Electrical and Environmental* on page 146
- *IMU- μ IMU Cables* on page 147

A.9.1 IMU- μ IMU Mechanical Drawings


 The dimensions in the following diagrams are in millimetres.

Figure 56: IMU- μ IMU Dimensions

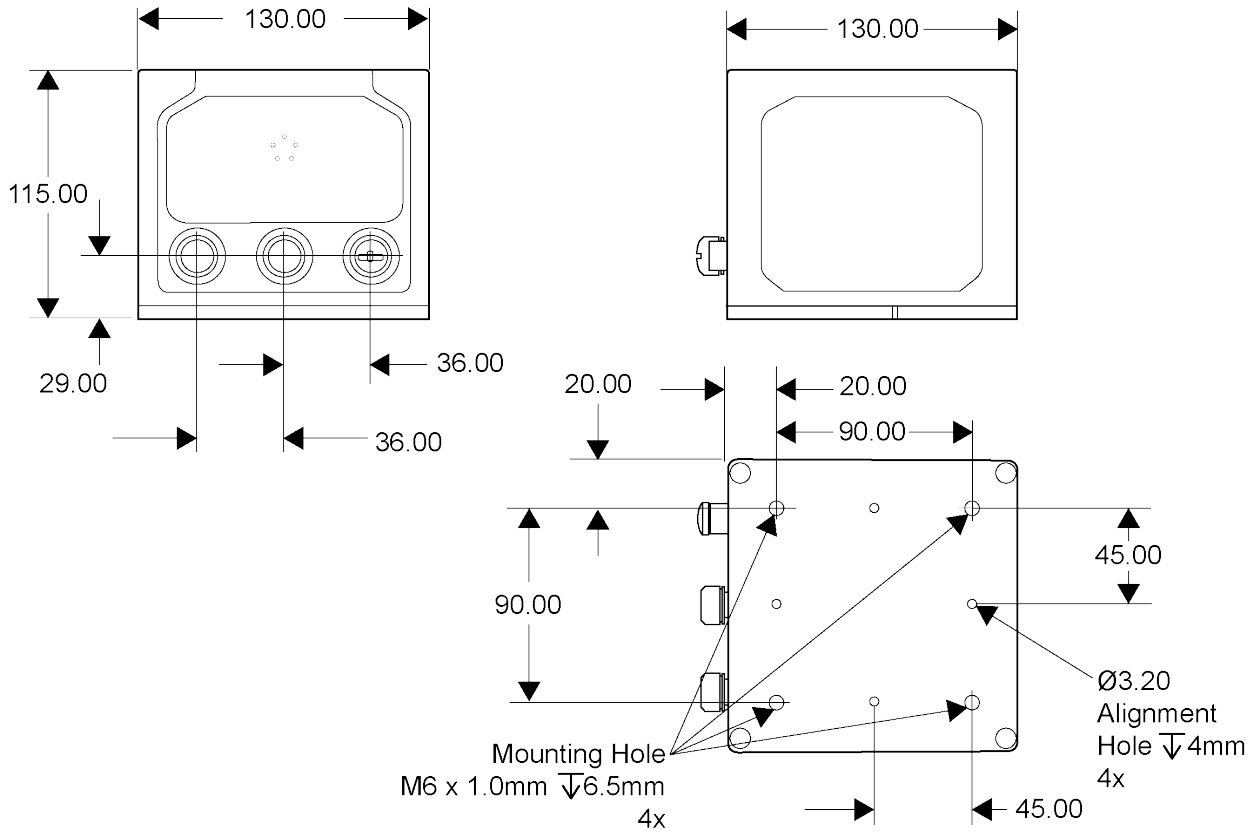
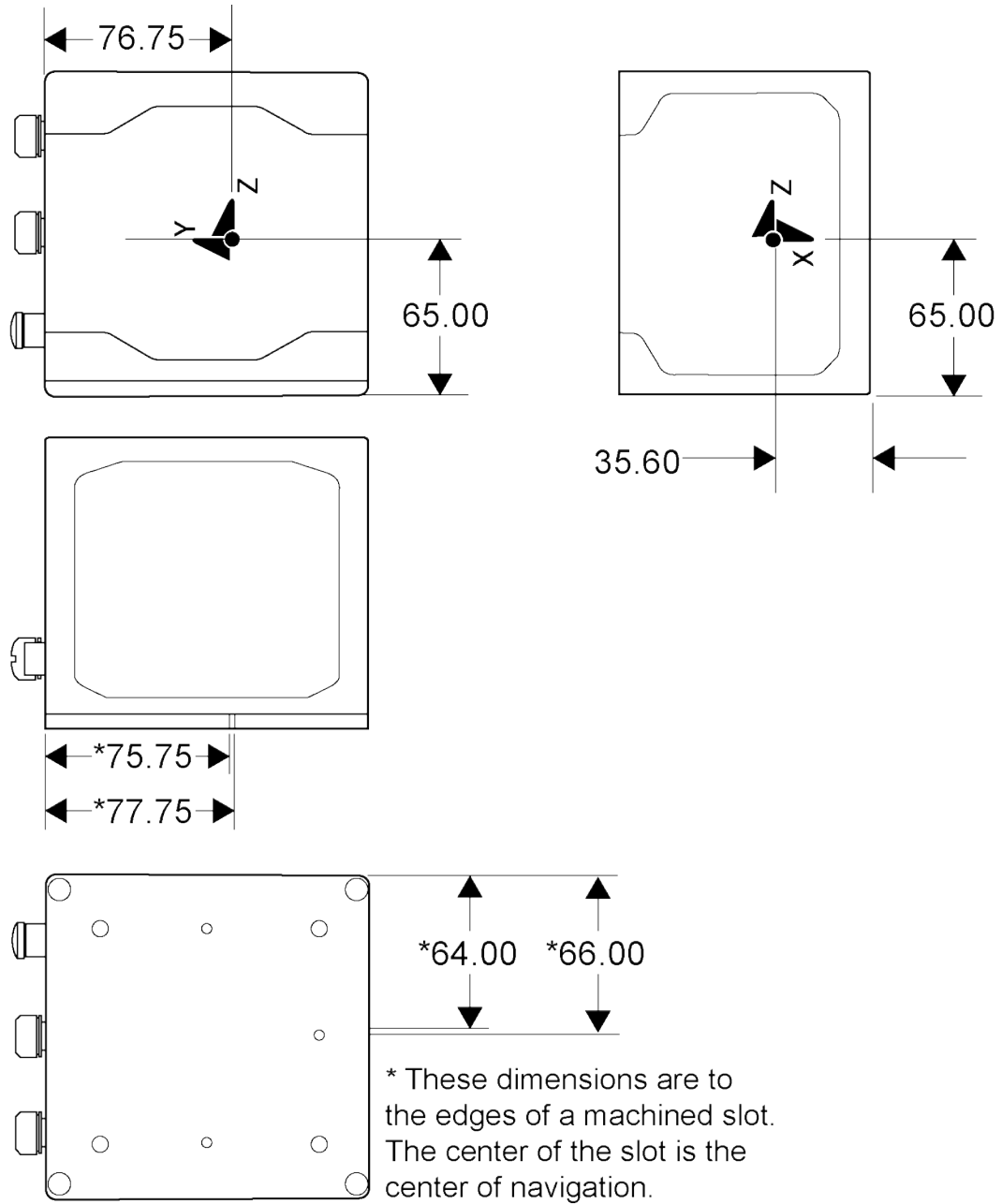


Figure 57: IMU-μIMU Center of Navigation



A.9.2 IMU- μ IMU Sensor Specifications**Table 80: IMU- μ IMU IMU Performance**

Gyroscope Performance	
Input range	± 499 deg/sec
Bias stability	≤ 6 deg/hr
Scale factor error	≤ 1400 ppm
Angular random walk	≤ 0.3 deg/ $\sqrt{\text{hr}}$
Accelerometer Performance	
Input range	± 15 g
Bias repeatability	≤ 3 mg
Scale factor error	≤ 1500 ppm
Velocity random walk	≤ 0.25 mg/deg/ $\sqrt{\text{hz}}$
Data Rate	
IMU Measurement	200 Hz

A.9.3 IMU- μ IMU Electrical and Environmental**Table 81: IMU- μ IMU Electrical Specifications**

Electrical	
IMU Power Consumption	11 W (typical)
IMU Input Voltage	+10 to +34 V DC
IMU Interface	RS-422
Connectors	
Power	SAL M12, 5 pin, male
Data	SAL M12, 5 pin, female
Wheel Sensor	SAL M12, 8 pin, male

Table 82: IMU- μ IMU Environmental Specifications

Environmental	
Operating Temperature	-40°C to +55°C
Storage Temperature	-40°C to +80°C
Humidity	MIL-STD-810G, Method 507.5
Random Vibe	MIL-STD-810G, Method 514.6 (2.0 g)
Environment	IEC 60529 IP67

A.9.4 IMU- μ IMU Cables

IMU- μ IMU Interface Cable

The IMU- μ IMU uses the IMU Enclosure Interface Cable. Refer to *IMU Enclosure Interface Cable* on page 123 for details about this cable.

IMU- μ IMU Power Cable

The IMU- μ IMU uses the IMU Enclosure Power Cable. Refer to *IMU Enclosure Power Cable* on page 124 for details about this cable.

IMU- μ IMU Wheel Sensor Cable

The IMU- μ IMU uses the IMU Enclosure Wheel Sensor Cable. Refer to *IMU Enclosure Wheel Sensor Cable* on page 125 for details about this cable.

A.10 LN-200 IMU (single-connector enclosure)

Table 83: LN-200 IMU Physical Specifications

Physical	
IMU Enclosure Size	135 mm x 153 mm x 130 mm (5.315" x 6.024" x 5.118")
IMU Size	89 mm D x 85 mm H (3.504" D x 3.346" H)
IMU Weight	3.19 kg (7.02 lb.)

See the following sections for more information about the LN-200 IMU.

- *LN-200 IMU Mechanical Drawings* on the next page
- *LN-200 IMU Performance* on page 151
- *LN-200 Electrical and Environmental* on page 151
- *Interface Cable for the LN-200 IMU* on page 152

A.10.1 LN-200 IMU Enclosure Top/Bottom Dimensions and Center of Navigation


 The dimensions in the following diagrams are in millimetres.

Figure 58: LN-200 IMU Enclosure Top/Bottom Dimensions and Center of Navigation

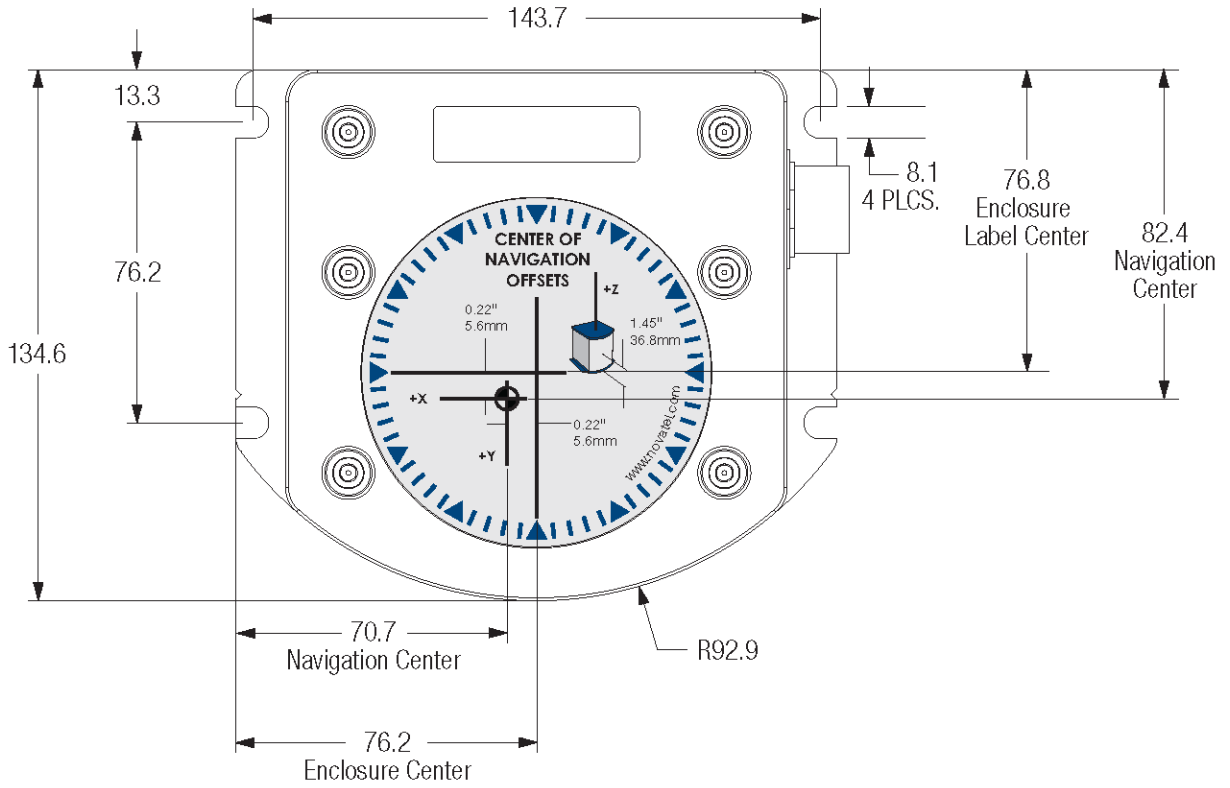
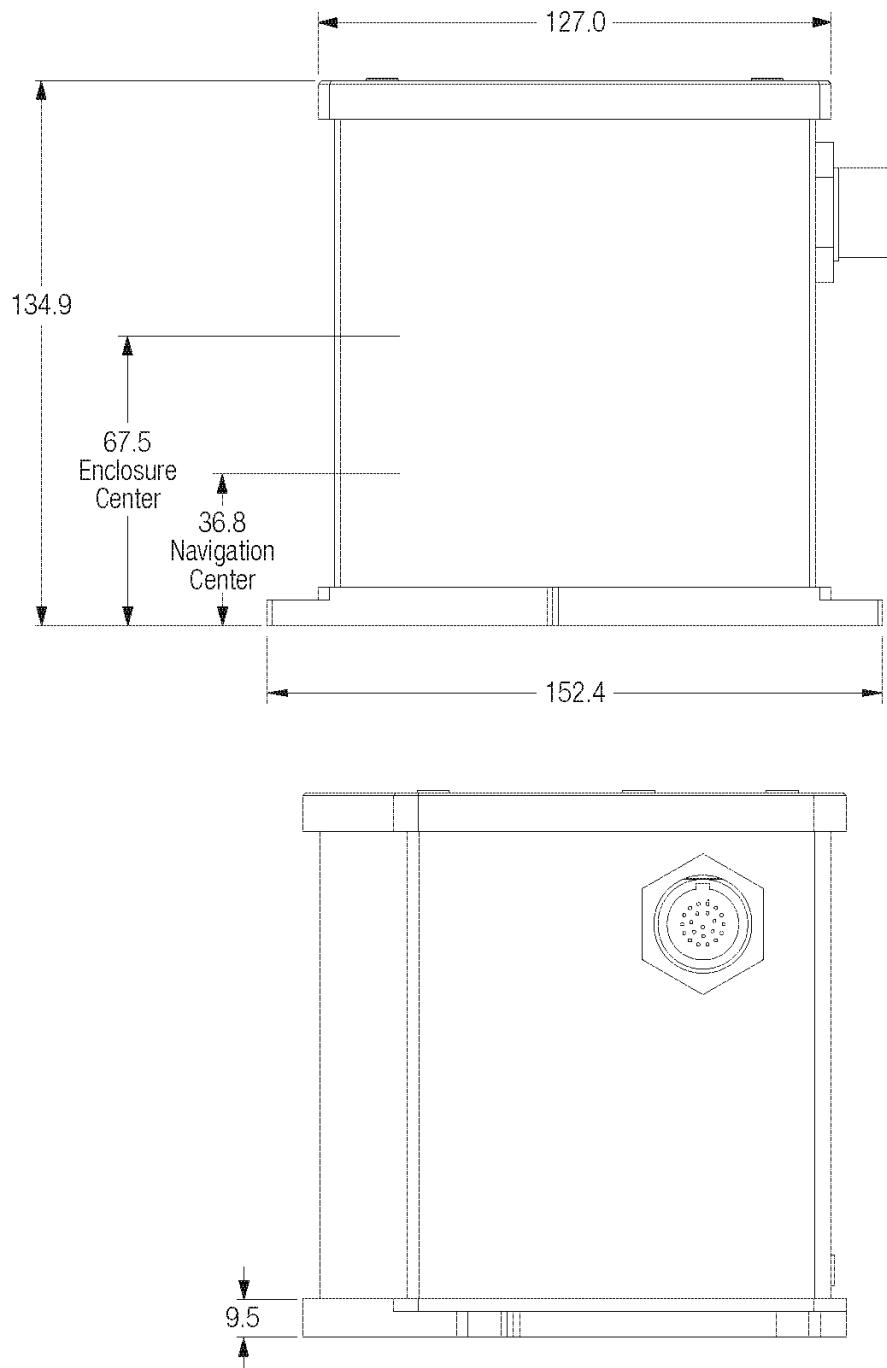


Figure 59: LN-200 Enclosure Side Dimensions



The Center of Navigation offsets, shown on the LN-200 label, are for the internal IMU and are different than for the enclosure center. The enclosure center is labelled as IMU Center in these figures. Dimensions are shown in millimeters.

A.10.2 LN-200 IMU Performance**Table 84: LN-200 IMU Performance**

Gyroscope Performance	
Gyro Input Range	±1000 degrees/s
Gyro Rate Bias	1°/hr
Gyro Rate Scale Factor	100 ppm
Angular Random Walk	0.07 degrees/rt-hr
Accelerometer Performance	
Accelerometer Range	±40 g
Accelerometer Linearity	150 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	0.3 mg
Data Rate	
IMU Measurement	200 Hz

A.10.3 LN-200 Electrical and Environmental**Table 85: LN-200 Electrical Specifications**

Electrical	
IMU Power Consumption	16 W (max)
IMU Input Voltage	+12 to +28 V DC
Receiver Power Consumption	1.8 W (typical)
System Power Consumption	13.8 W (typical)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMUs)
IMU Interface	RS-232 or RS-422

Table 86: LN-200 Environmental Specifications

Environmental (LN-200 IMU)	
Temperature	Operating -30°C to +60°C (-22°F to 140°F) Storage -45°C to +80°C (-49°F to 176°F)
Humidity	95% non-condensing

A.10.4 Interface Cable for the LN-200 IMU

The IMU interface cable provides power to the IMU from an external power source and enables communication between the receiver and IMU. The LN-200 IMU uses the Universal IMU Enclosure Interface cable (see *Universal IMU Enclosure Interface Cable* on page 181).

A.11 OEM-IMU-ADIS-16488



The OEM-IMU-ADIS-16488 requires a MEMS Interface Card to connect to a NovAtel receiver.

See *MIC - MEMS Interface Card* on page 184.

Table 87: OEM-IMU-ADIS-16488 Physical Specifications

Physical	
IMU Size	47 mm x 44 mm x 14 mm
IMU Weight	48 g
IMU with mounting PCB size	71.1 mm x 45.7 mm x 17.6 mm

See the following sections for more information about the OEM-IMU-ADIS-16488.

- *OEM-IMU-ADIS-16488 Mechanical Drawings* on the next page
- *OEM-IMU-ADIS-16488 Sensor Specifications* on page 156
- *OEM-IMU-ADIS-16488 Electrical and Environmental* on page 156
- *ADIS-16488 IMU-to-MIC Cable Assembly* on page 156

A.11.1 OEM-IMU-ADIS-16488 Mechanical Drawings


 The dimensions in these drawings are in millimetres.

Figure 60: ADIS-16488 Dimensions

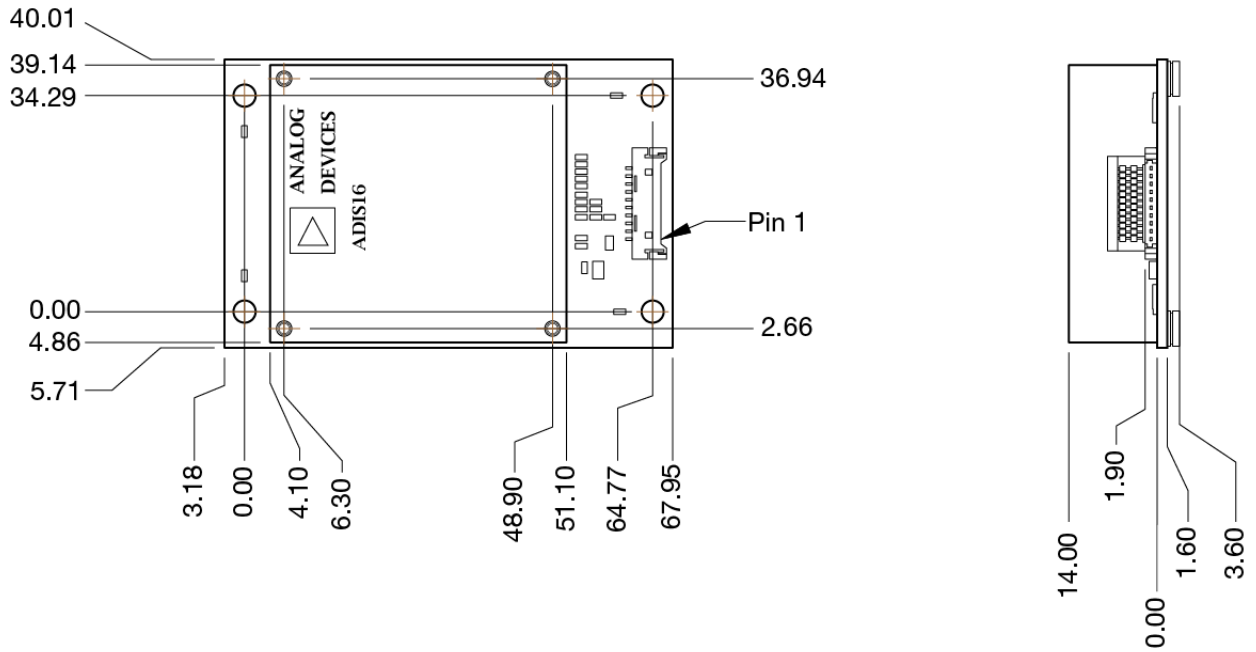
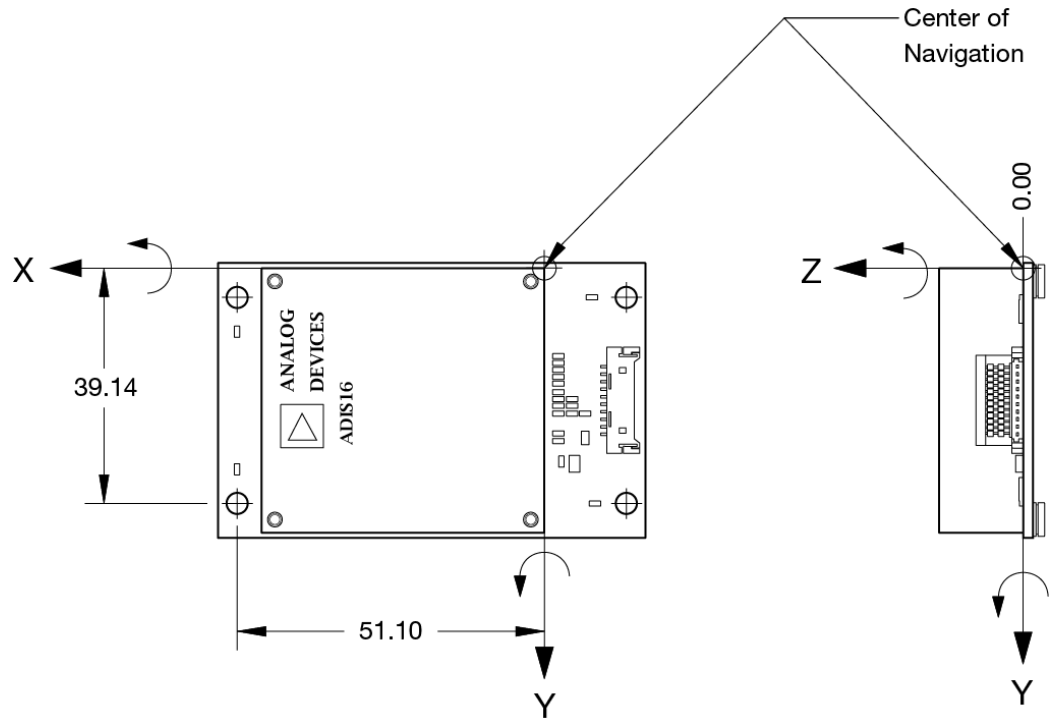


Figure 61: ADIS-16488 Center of Navigation



A.11.2 OEM-IMU-ADIS-16488 Sensor Specifications**Table 88: OEM-IMU-ADIS-16488 Performance**

Gyroscope Performance	
Gyro Input Range	±450°/second
In-run Gyro Rate Bias Stability	6.25°/hour
Angular Random Walk	0.30°/√hour
Accelerometer Performance	
Accelerometer Range	±18 g
In-run Accelerometer Bias Stability	0.1 mg
Velocity Random Walk	0.029 m/s√hour
Data Rate	
IMU Measurement	200 Hz

A.11.3 OEM-IMU-ADIS-16488 Electrical and Environmental**Table 89: OEM-IMU-ADIS-16488 Electrical Specifications**

Electrical	
Input Power	+3.0 to + 3.6 V DC +3.3 V DC typical
Power consumption	254 mA typical
IMU Interface	SPI

Table 90: OEM-IMU-ADIS-16488 Environmental Specifications

Environmental	
Temperature, operational	-40°C to +85°C
Temperature, non-operational	-40°C to +105°C

A.11.4 ADIS-16488 IMU-to-MIC Cable Assembly

The NovAtel part number for the ADIS-16488 IMU-to-MIC interface cable is 01019008 (*Figure 62: ADIS-16488 IMU-to-MIC Cable Assembly* on the next page). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 62: ADIS-16488 IMU-to-MIC Cable Assembly

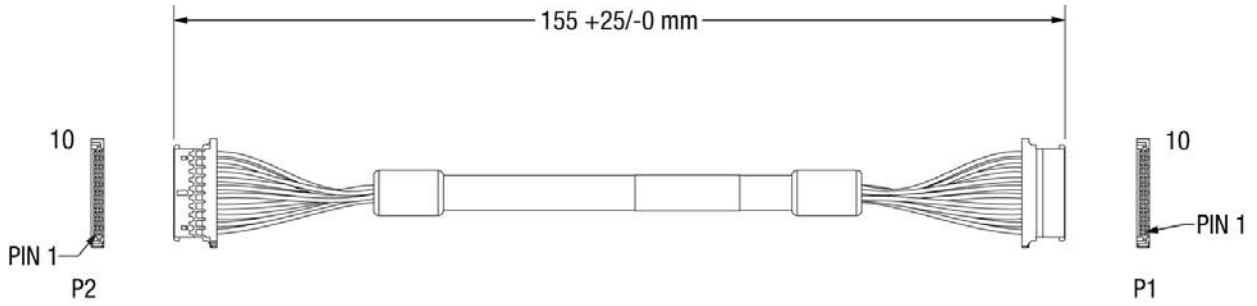


Table 91: ADIS-16488 IMU-to-MIC Cable Pinout

P2 Pin	Signal Name	P1 Pin
1	IMU_VDD	1
2	IMU_VDD	2
3	SPI_NSS	3
4	SPI_CLK	4
5	Ground	5
6	SPI_MOSI	6
7	SPI_MISO	7
8	Ground	8
9	ADIS_IMU_DIO1	9
10	ADIS_IMU_DIO2	10

A.12 OEM-IMU-ISA-100C



The OEM-IMU-ISA-100C requires a Universal IMU Controller Card to connect to a NovAtel receiver. See *UIC - Universal IMU Controller* on page 196.

Table 92: OEM-IMU-ISA-100C Physical Specifications

Physical	
IMU Size	100 mm x 130 mm x 125 mm
IMU Weight	2 kg

See the following sections for more information about the OEM-IMU-ISA-100C IMU.

- *OEM-IMU-ISA-100C Mechanical Drawings* on the next page
- *OEM-IMU-ISA-100C Sensor Specifications* on page 161
- *OEM-IMU-ISA-100C Electrical and Environmental* on page 161
- *OEM-IMU-ISA-100C IMU to UIC Cable Assembly* on page 162

A.12.1 OEM-IMU-ISA-100C Mechanical Drawings



The following graphics are courtesy of Northrop Grumman LITEF GmbH.



The dimensions in the following graphics are in millimetres.

Figure 63: ISA-100C Dimensions

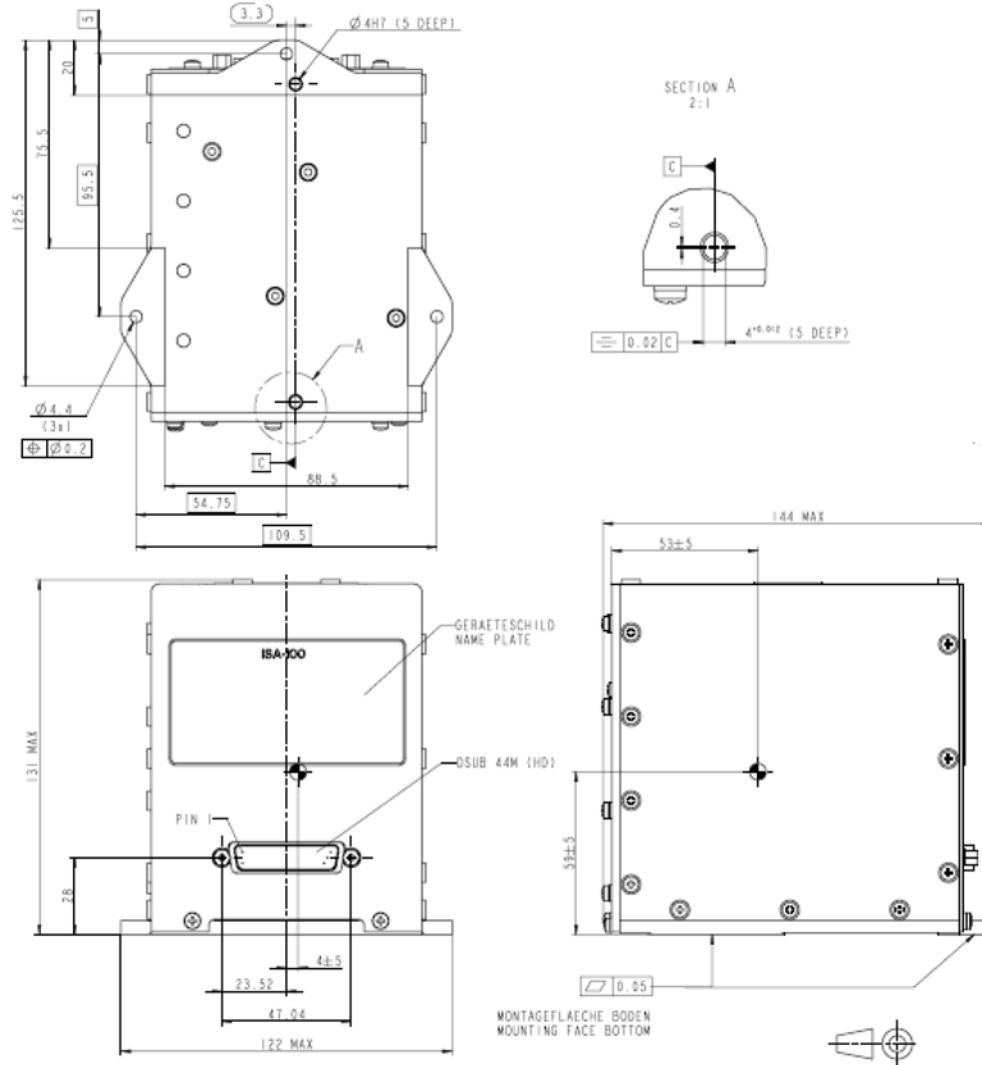
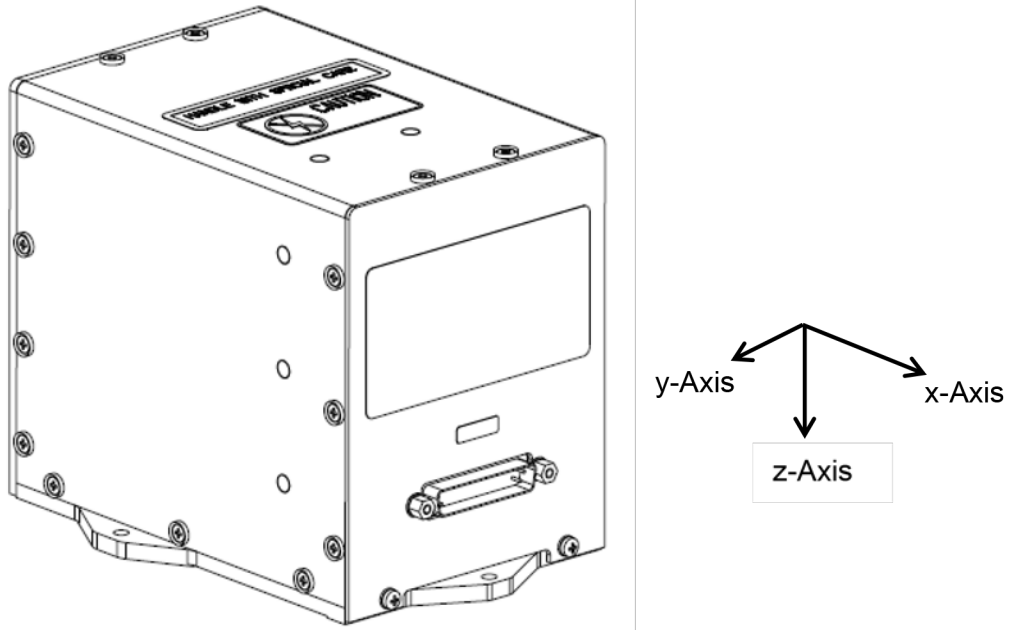


Figure 64: ISA-100C Coordinate Axis



A.0.1 OEM-IMU-ISA-100C Sensor Specifications

Table 93: OEM-IMU-ISA-100C IMU Performance

Gyroscope Performance	
Input range	±495 deg/sec
In-run bias stability	≤0.05 deg/hr
Scale factor repeatability	≤100 ppm
Scale factor non-linearity	≤100 ppm
Angular random walk	0.012 deg/√hr
Accelerometer Performance	
Range	±10 g
In-run bias stability	≤100 μg
1 year scale factor repeatability	≥1250 μg
Scale factor non-linearity	≤100 ppm
Velocity random walk	≤100 μg/√Hz
Data Rate	
IMU Measurement	200 Hz

A.12.2 OEM-IMU-ISA-100C Electrical and Environmental

Table 94: OEM-IMU-ISA-100C Electrical Specifications

Electrical	
Input Power	+3.3 V, ±5.25 V, ±15 V, -15 V (optional)
Power consumption	≤10 W (typical) 16 W (maximum)
Connector	44 pin HD D-Sub, male

Table 95: OEM-IMU-ISA-100C Environmental Specifications

Environmental	
Temperature, operational	-40°C to +71°C

A.12.3 OEM-IMU-ISA-100C IMU to UIC Cable Assembly

The NovAtel part number for the OEM-IMU-ISA-100C IMU to UIC interface cable is 01019393 (Figure 65: OEM-IMU-ISA-100C IMU to UIC Cable Assembly below). This cable provides power to the IMU and enables communication between the UIC and the IMU.

Figure 65: OEM-IMU-ISA-100C IMU to UIC Cable Assembly

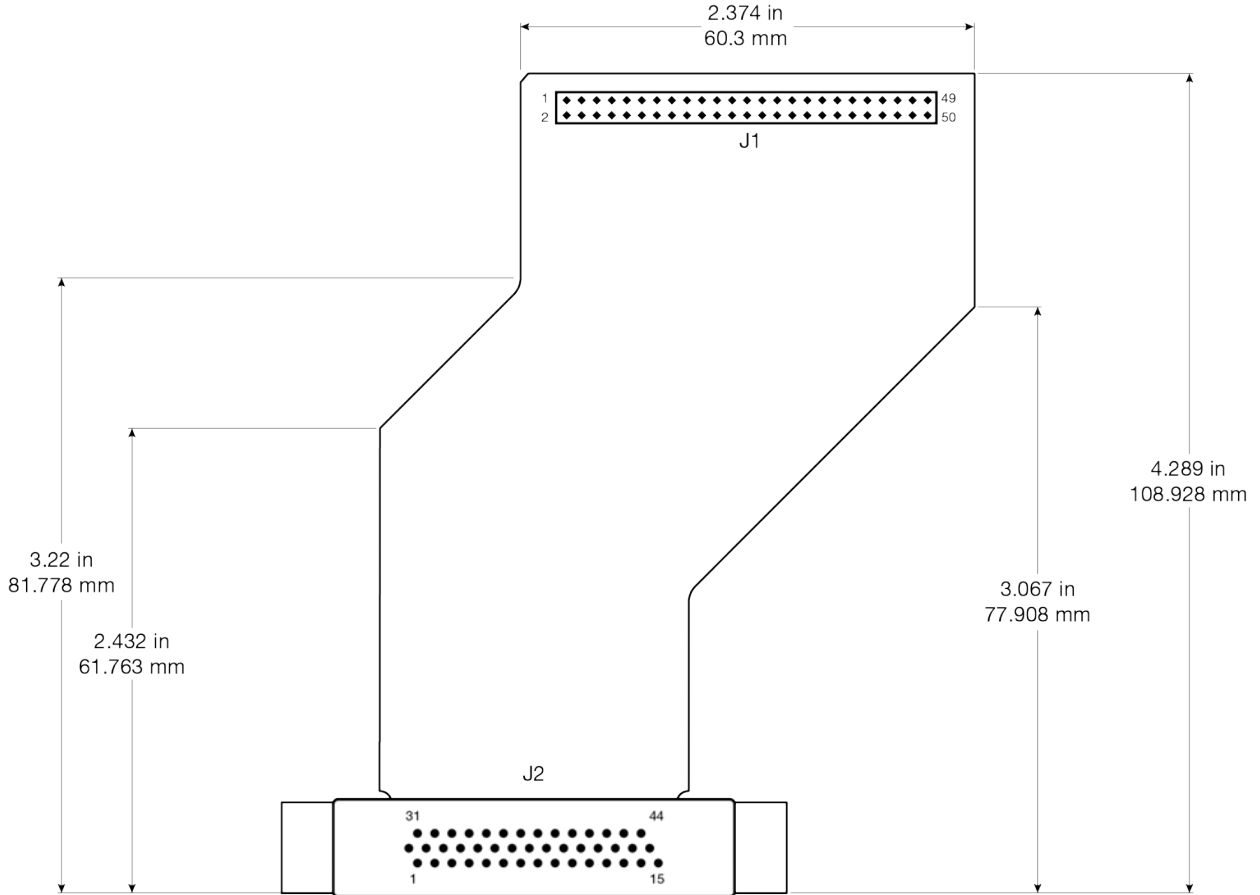


Table 96: OEM-IMU-ISA-100C IMU to UIC Cable Pinout

J2 Pin (ISA-100C)	Signal	J1 Pin (UIC)
1	GND	9
2	3.3 V	1
3	GND	4
4	GND	5
5	GND	6
6	GND	8

J2 Pin (ISA-100C)	Signal	J1 Pin (UIC)
7	GND	10
8	GND	15
9	GND	16
10	GND	21
11	GND	22
12	5.25 V	43
13	-5.25 V	49
14	-5.25 V	50
15	-5.25 V	
16	15 V	7
17	3.3 V	3
18	GND	28
19	-	-
20	-	-
21	NOGOx	18
22	-	-
23	GND	29
	GND	35
24	TXC+	32
25	SYNC-	34
26	GND	41
27	TXD+	40
28	-	-
29	GND	42
30	5.25 V	44
31	3.3 V	2
32	3.3 V	

J2 Pin (ISA-100C)	Signal	J1 Pin (UIC)
33	PWRDOWNx	12
34	RESETIMUx	14
35	-	-
36	GND	45
37	-	-
38	TXC-	30
39	GND	48
40	SYNC+	36
41	TXD-	38
42	-	-
43	GND	48
44	5.25 V	46

A.13 OEM-IMU-STIM300



The OEM-IMU-STIM300 requires a MEMS Interface Card to connect to a NovAtel receiver.

See *MIC - MEMS Interface Card* on page 184.

Table 97: OEM-IMU-STIM300 Physical Specifications

Physical	
IMU Size	45 mm x 39 mm x 22 mm
IMU Weight	55 g

See the following sections for more information about the OEM-IMU-STIM300 IMU.

- *OEM-IMU-STIM300 Mechanical Drawings* on the next page
- *OEM-IMU-STIM300 Sensor Specifications* on page 167
- *OEM-IMU-STIM300 Electrical and Environmental* on page 167
- *STIM300 IMU-to-MIC Cable Assembly* on page 167

A.13.1 OEM-IMU-STIM300 Mechanical Drawings

 The following graphics are courtesy of Sensoror AS.


 In the following graphics, the dimensions are in millimetres.

Figure 66: STIM300 Dimensions

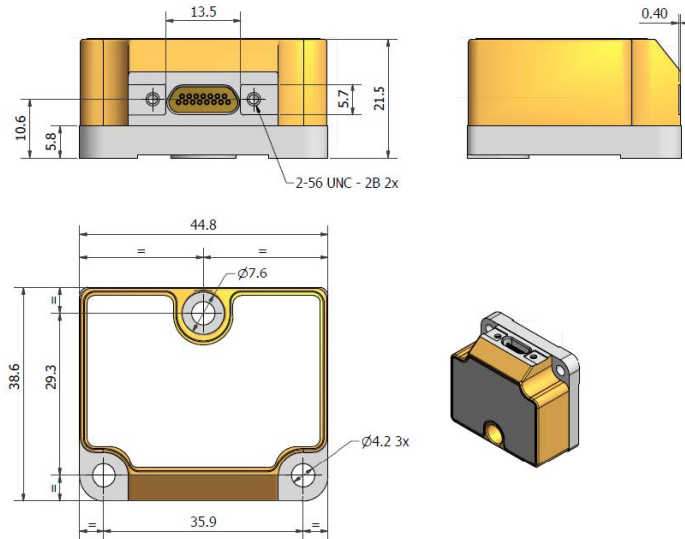
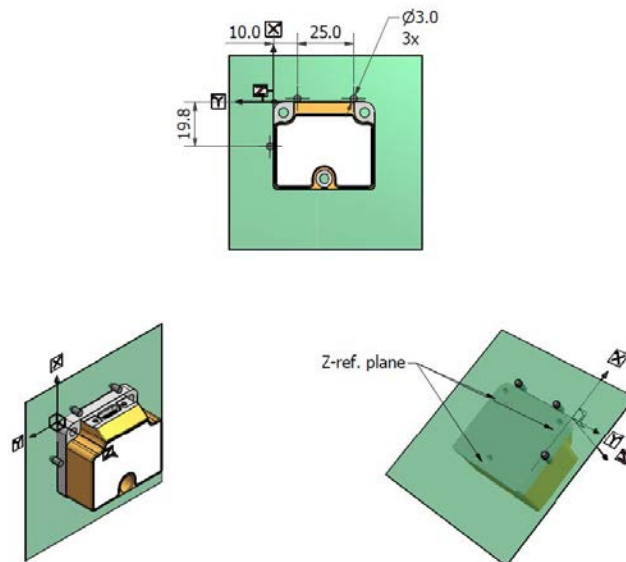


Figure 67: STIM300 Center of Navigation



A.13.2 OEM-IMU-STIM300 Sensor Specifications**Table 98: OEM-IMU-STIM300 Performance**

Gyroscope Performance	
Gyro Input Range	±400°/second
In-run Gyro Rate Bias Stability	0.5°/hour
Angular Random Walk	0.15°/√hour
Accelerometer Performance	
Accelerometer Range	±10 g
In-run Accelerometer Bias Stability	0.05 mg
Velocity Random Walk	0.07 m/s√hour
Data rate	
IMU Measurement	125 Hz

A.13.3 OEM-IMU-STIM300 Electrical and Environmental**Table 99: OEM-IMU-STIM300 Electrical Specifications**

Electrical	
Input Power	+4.5 to +5.5 V DC +5.0 V DC typical
Power consumption	1.5 W nominal
Connector	15 pin Micro-D, female

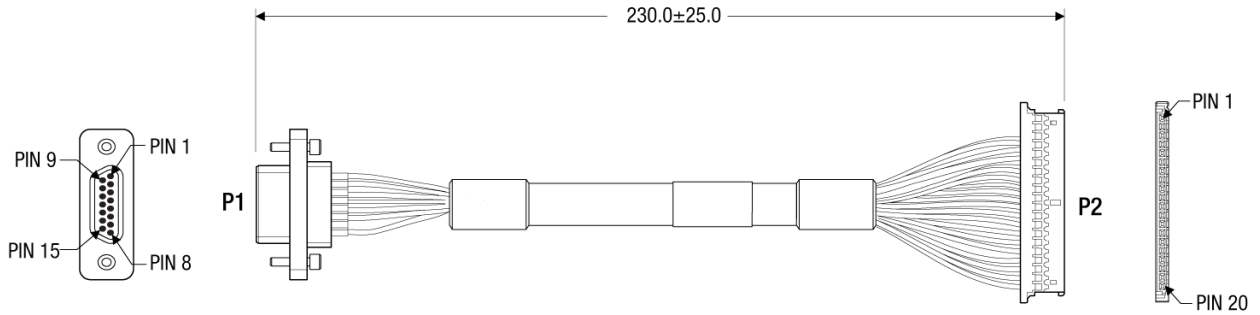
Table 100: OEM-IMU-STIM300 Environmental Specifications

Environmental	
Temperature, operational	-40°C to +85°C
Temperature, non-operational	-55°C to +90°C

A.13.4 STIM300 IMU-to-MIC Cable Assembly

The NovAtel part number for the STIM300 IMU-to-MIC interface cable is 01019161 (*Figure 68: STIM300 IMU-to-MIC Cable Assembly* on the next page). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 68: STIM300 IMU-to-MIC Cable Assembly



The dimensions in this drawing are in millimetres.

Table 101: STIM300 IMU-to-MIC Cable Pinout

P2 Pin (MIC)	Signal	P1 Pin (STIM300)
1	No connection	–
2	No connection	–
3	No connection	–
4	No connection	–
5	No connection	–
6	Ground	12
7	Ground	13
8	VSUP (5V input)	8
9	VSUP (5V input)	
10	Ground	15
11	Transmit Data+	10
12	Transmit Data-	2
13	Receive Data+	9
14	Receive Data-	1
15	No connection	–
16	No connection	–
17	IMU DAS	4
18	No connection	–
19	IMUTYPE1	15
20	No connection	–

A.14 OEM-IMU- μ IMU



The OEM-IMU- μ IMU requires a Universal IMU Controller to connect to a NovAtel receiver.

See *UIC - Universal IMU Controller* on page 196.

Table 102: OEM-IMU- μ IMU Physical Specifications

Physical	
IMU Size (\varnothing x H)	85 mm x 60 mm
IMU Weight	0.68 kg

See the following sections for more information about the OEM-IMU- μ IMU.

- *OEM-IMU- μ IMU Mechanical Drawings* below
- *OEM-IMU- μ IMU Sensor Specifications* on page 171
- *OEM-IMU- μ IMU Electrical and Environmental* on page 172
- *μ IMU to UIC Cable Assembly* on page 172

A.14.1 OEM-IMU- μ IMU Mechanical Drawings



The following graphics are courtesy of Northrop Grumman LITEF GmbH.



The dimensions in the following graphics are in millimetres.

Figure 69: μ IMU Dimensions

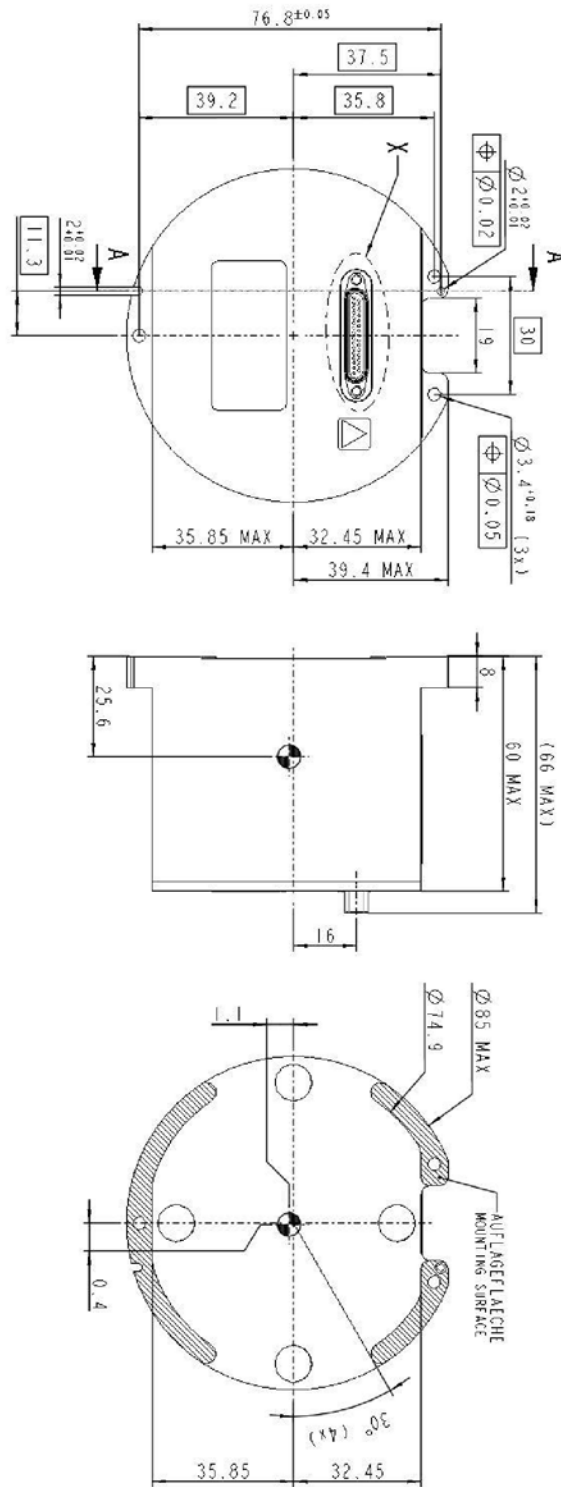
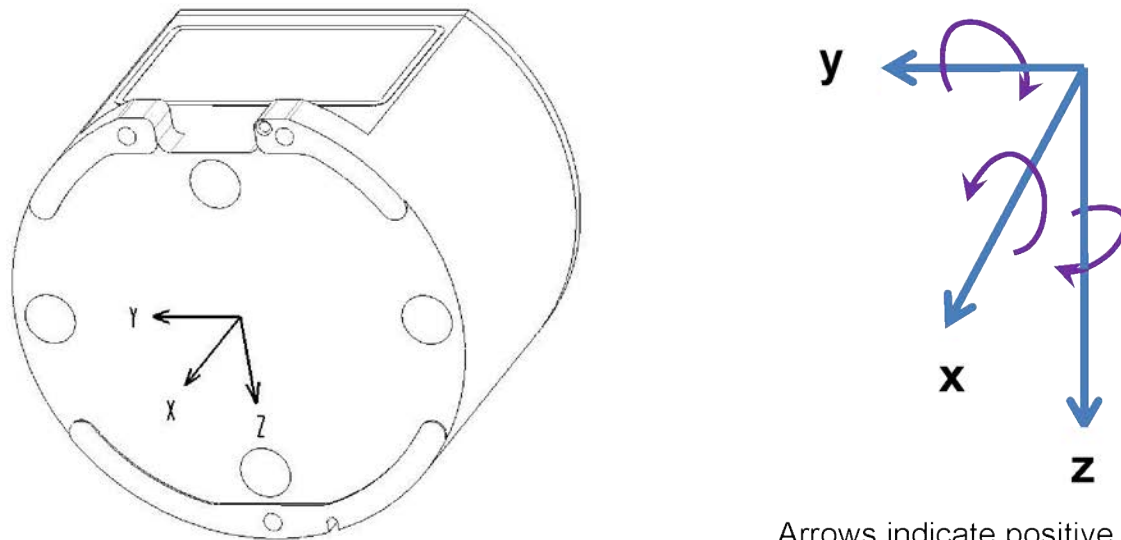


Figure 70: μ IMU Coordinate Axis



Arrows indicate positive values.

A.14.2 OEM-IMU- μ IMU Sensor Specifications

Table 103: OEM-IMU- μ IMU IMU Performance

Gyroscope Performance	
Input range	± 499 deg/sec
Bias stability	≤ 6 deg/hr
Scale factor error	≤ 1400 ppm
Angular random walk	≤ 0.3 deg/ $\sqrt{\text{hr}}$
Accelerometer Performance	
Input range	± 15 g
Bias repeatability	≤ 3 mg
Scale factor error	≤ 1500 ppm
Velocity random walk	≤ 0.25 mg/deg/ $\sqrt{\text{hz}}$
Data Rate	
IMU Measurement	200 Hz

A.14.3 OEM-IMU-μIMU Electrical and Environmental

Table 104: OEM-IMU-μIMU Electrical Specifications

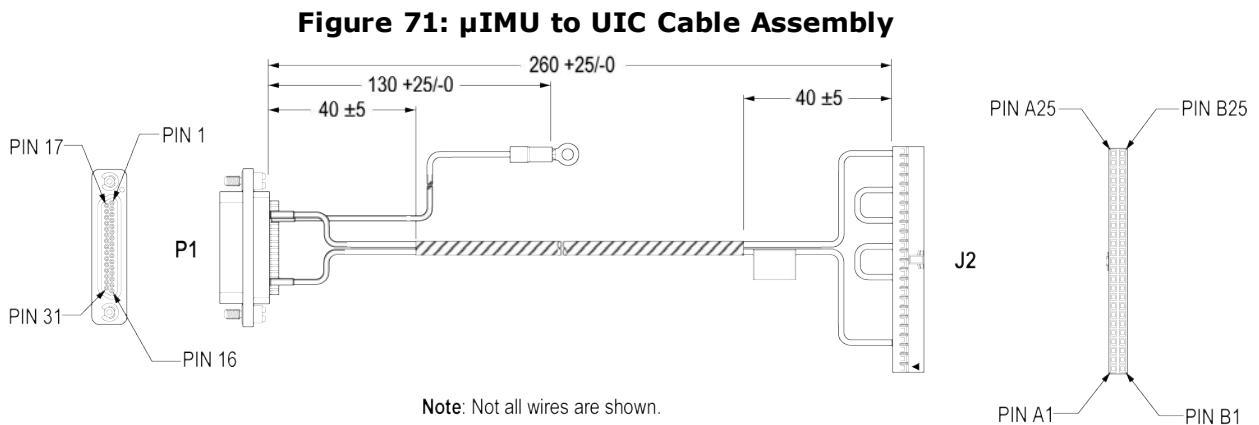
Electrical	
Input Power	+5.0 V DC
Power consumption	<8 W
Connector	31 pin Micro-D, plug

Table 105: OEM-IMU-μIMU Environmental Specifications

Environmental	
Temperature, operational	-55°C to +71°C

A.0.2 μIMU to UIC Cable Assembly

The NovAtel part number for the μIMU to UIC interface cable is 01019760 (Figure 71: μIMU to UIC Cable Assembly below). This cable provides power to the IMU and enables communication between the UIC and the IMU.



The dimensions in this drawing are in millimetres.

Table 106: μIMU to UIC Cable Pin-out

P1 Pin (μIMU)	Signal	J2 Pin (UIC)
1	Ground	B2
2	Ground	A3

P1 Pin (μIMU)	Signal	J2 Pin (UIC)
3	Transmit Data+	B20
4	Transmit Data-	B19
5	Transmit Clock-	B15
6	Transmit Clock+	B16
7	Ground	B3
8	Ground	B4
13	NOGO	B9
16	SYNC-	B17
17	IMU_5V25	A22
18	IMU_5V25	B22
19	IMU_5V25	B23
20	Ground	A21 B21
21	Ground	B5 B11
22	Ground	A23 B24
26	Lug Ring	-
27	IMU_PDWARN	B6
30	IMU_RESET	B7
31	SYNC+	B18
	IMU_TYPE_3	A15 to A18
	IMU_TYPE_1	A13 to A11

A.15 Universal IMU Enclosure (HG1700, LN200)

The Universal IMU Enclosure is available with the HG1700 and LN-200 IMUs.

Table 107: Universal IMU Enclosure Physical Specifications

PHYSICAL	
IMU Enclosure Size	168 mm x 195 mm x 146 mm
IMU Enclosure Weight	4.25 kg

See the following sections for more information about the IMUs available in the Universal IMU Enclosure.

- *Universal IMU Enclosure Mechanical Drawings* on the next page
- *IMU Performance* on page 179
- *Electrical and Environmental* on page 180
- *Universal IMU Enclosure Interface Cable* on page 181

A.15.1 Universal IMU Enclosure Mechanical Drawings


 The dimensions for the drawing in this section are in mm [inches].

Figure 72: Universal IMU Enclosure Side Dimensions

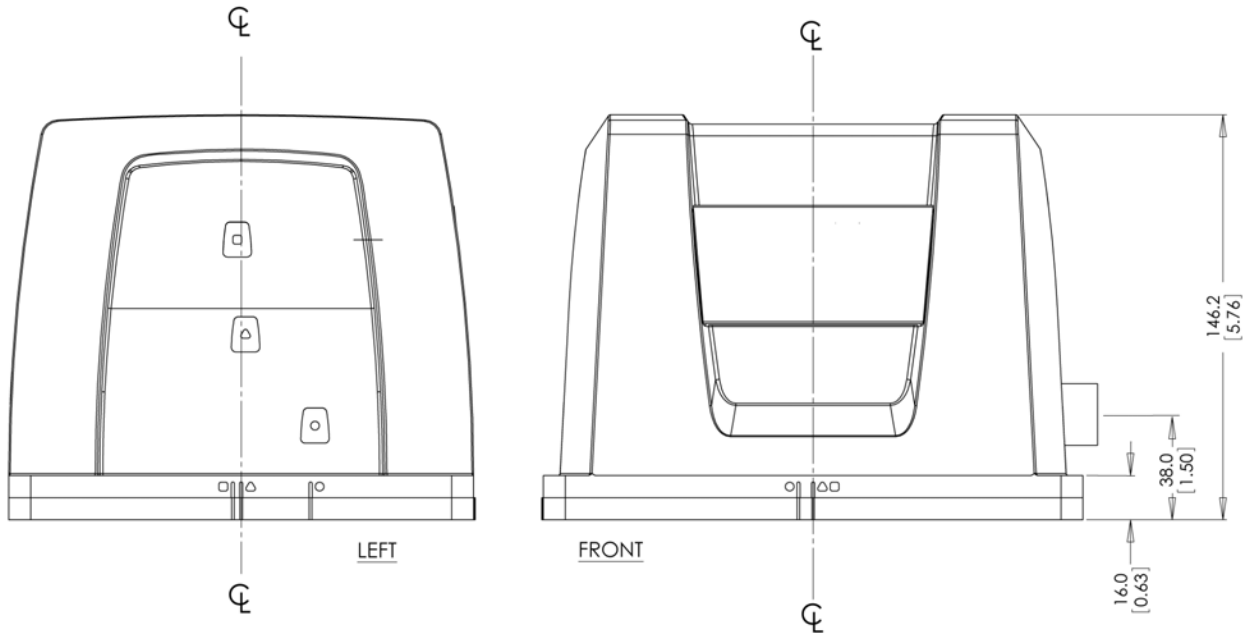


Figure 73: Universal IMU Enclosure Top/Bottom Dimensions

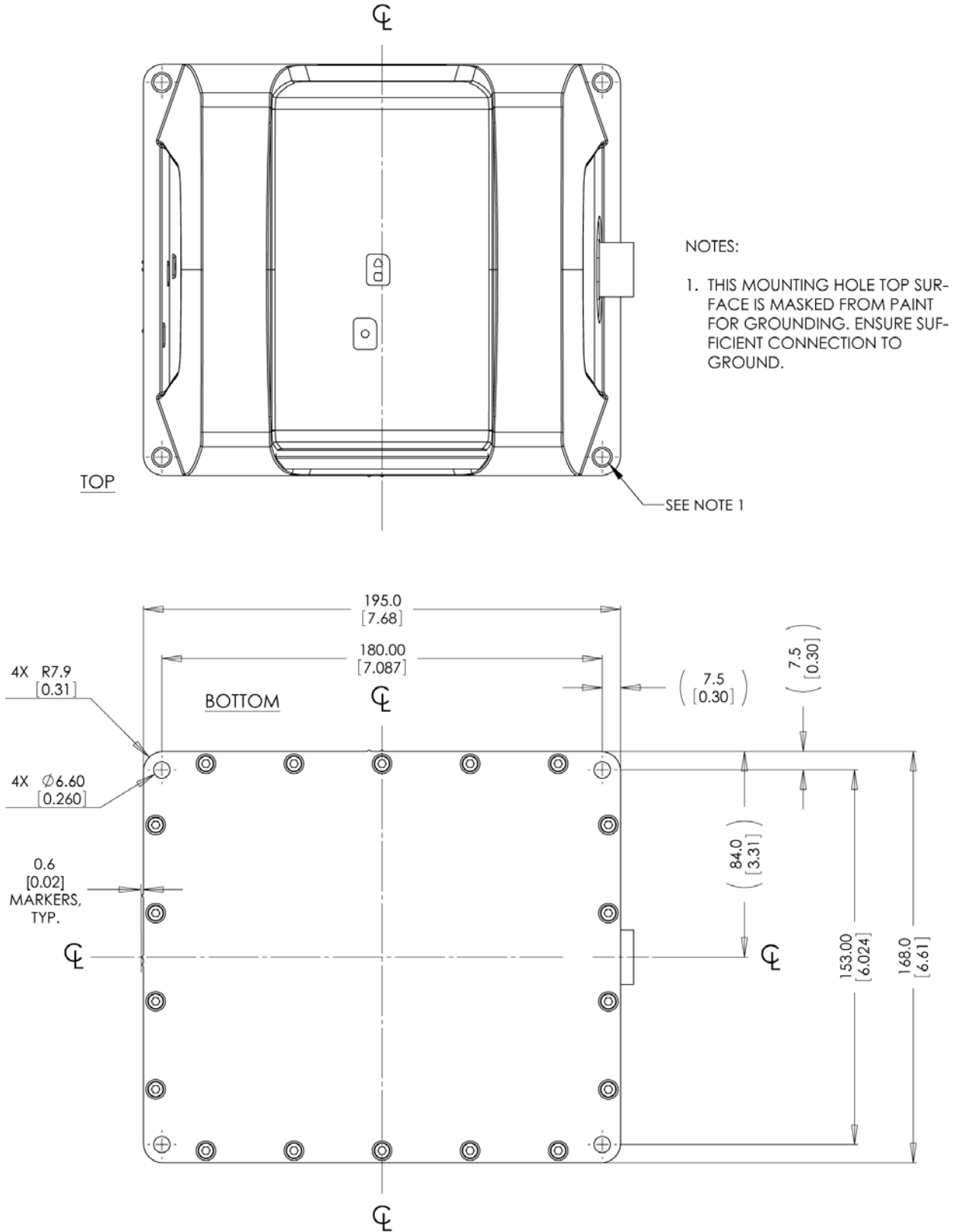


Figure 74: Universal IMU Center of Navigation

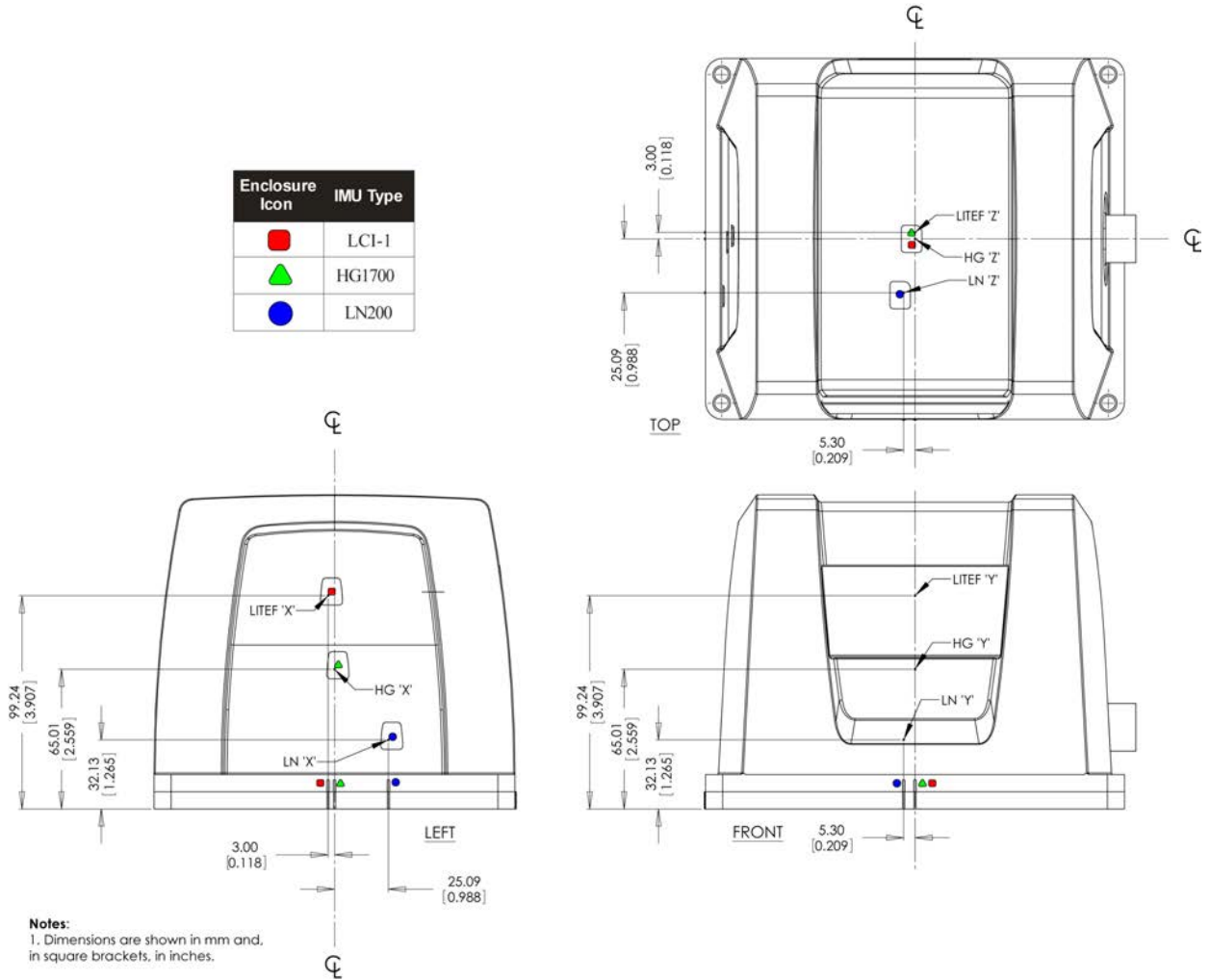
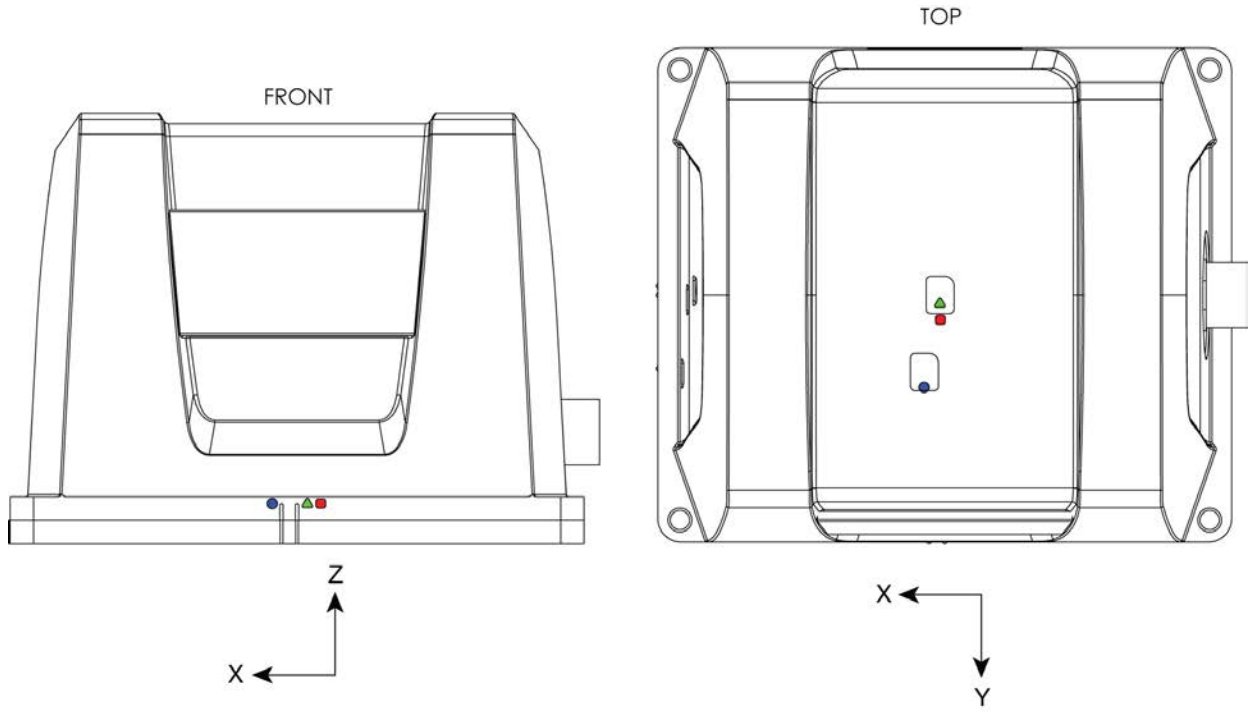


Figure 75: Universal IMU Frame Axis



A.15.2 IMU Performance**Table 108: HG1700-AG58 IMU Performance**

Gyroscope Performance	
Gyro Input Range	±1000 deg/sec
Gyro Rate Bias	1.0 deg/hr
Gyro Rate Scale Factor	150 ppm
Angular Random Walk	0.125 deg/rt-hr
Accelerometer Performance	
Accelerometer Range	±50 g
Accelerometer Linearity	500 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	1.0 mg
Data Rate	
IMU Measurement	100 Hz

Table 109: HG1700-AG62 IMU Performance

Gyroscope Performance	
Gyro Input Range	±1000 deg/sec
Gyro Rate Bias	5.0 deg/hr
Gyro Rate Scale Factor	150 ppm
Angular Random Walk	0.5 deg/rt-hr
Accelerometer Performance	
Accelerometer Range	±50 g
Accelerometer Linearity	500 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	2.0 mg
Data Rate	
IMU Measurement	100 Hz

Table 110: LN200 IMU Performance

Gyroscope Performance	
Gyro Input Range	±1000 deg/sec
Gyro Rate Bias	1.0 deg/hr
Gyro Rate Scale Factor	100 ppm
Angular Random Walk	0.07 deg/rt-hr
Accelerometer Performance	
Accelerometer Range	±40 g
Accelerometer Linearity	150 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	0.3 mg
Data Rate	
IMU Measurement	200 Hz

A.15.3 Electrical and Environmental**Table 111: Universal IMU Enclosure Electrical Specifications**

Electrical	
IMU Power Consumption	HG1700-AG58: 9 W (max) HG1700-AG62: 8 W (max) LN-200: 16 W (typical)
IMU Input Voltage	+12 to +28 V DC (all IMUs)
Receiver Power Consumption	1.8 W (typical, for all IMUs)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMUs)
IMU Interface	RS-232 or RS-422

Table 112: Universal IMU Enclosure Environmental Specifications

Environmental	
Temperature	HG1700-AG58, HG1700-AG62 Operating: -30°C to +60°C Storage: -45°C to +80°C
	LN-200 Operating: -30°C to +60°C Storage: -45°C to +80°C
Humidity	Operates at 95% RH, non-condensing (all IMUs)

A.15.4 Universal IMU Enclosure Interface Cable

The NovAtel part number for the Universal IMU Enclosure interface cable is 01018977 (see *Figure 76: Universal IMU Enclosure Interface Cable* below). This cable provides power to the IMU from an external power source and enables communication between the receiver and the IMU.

Figure 76: Universal IMU Enclosure Interface Cable

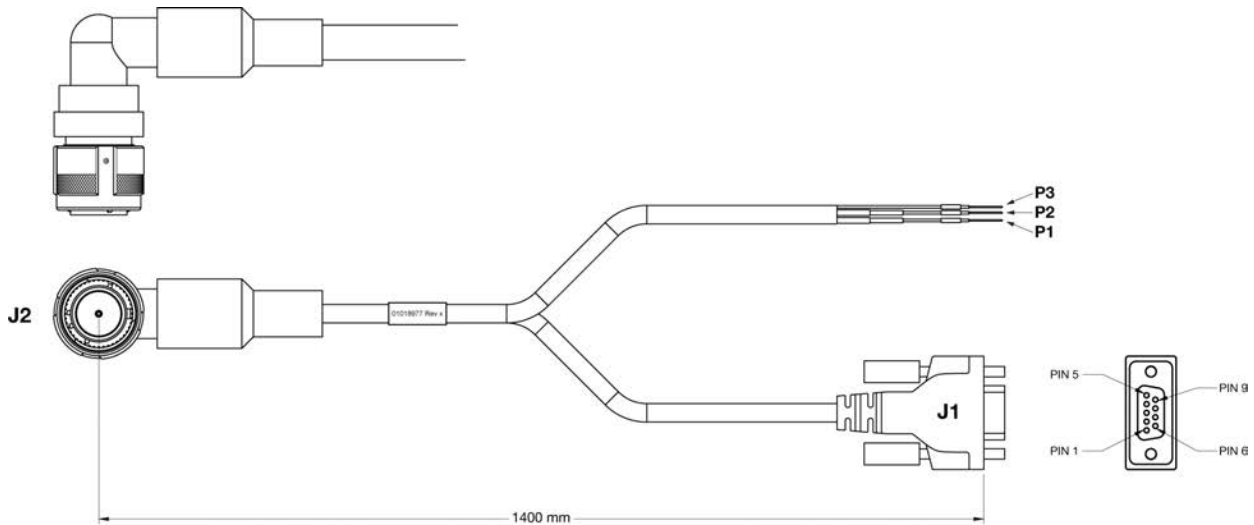


Table 113: Universal IMU Enclosure Interface Cable Pinouts

J2 Pinout	Function	Connector	Pin/Label
1	$V_{IN} (-)$	P2	Vin (-)
22	$V_{IN} (-)$		
2	Not used		

J2 Pinout	Function	Connector	Pin/Label
3	V _{IN} (+)	P1	Vin (+)
21	V _{IN} (+)		
4	Not used		
5	Not used		
6	Not used		
7	DAS (+)	J1	1
8	Not used		
9	DAS GND (-)	J1	5
10	Not used		
11	OEM_CTS/Rx-	J1	8
12	OEM_Rx/Rx+	J1	2
13	Not used		
14	DGND	J1	5
15	DGND	J1	5
16	Not used		
17	Not used		
18	Not used		
19	OEM_Tx/Tx+	J1	3
20	OEM_RTS/Tx-	J1	7
	Shield	P3	Shield

Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the Universal IMU Enclosure interface cable (01018977).

Table 114: Connectors

Connector	Description
J1	DB-9, female
J2	MIL-DTL-38999 III, plug

Table 115: Maximum Cable Length

IMU	RS-232	RS-422
HG1700, LN-200, LCI-1	< 2.0 metres	< 50 metres
iIMU-FSAS	N/A	< 1.5 metres

A.16 MIC - MEMS Interface Card

Table 116: MEMS Interface Card Physical Specifications

Physical	
MIC Size	74.9 mm x 45.7 mm x 19.5 mm (2.94" x 1.80" x 0.76")
MIC Weight	31 g (0.0683 lb)

See the following sections for more information about the MIC.

- *MIC Mechanical Drawings* on the next page
- *MIC Electrical and Environmental* on page 187
- *MIC Connectors* on page 187
- *HG1930 IMU-to-MIC Cable Assembly* on page 193
- *HG1700 and HG1900 IMU-to-MIC Cable Assembly* on page 194

A.16.1 MIC Mechanical Drawings


 The dimensions in the following drawings are in millimetres.

Figure 77: MIC Top/Bottom Dimensions

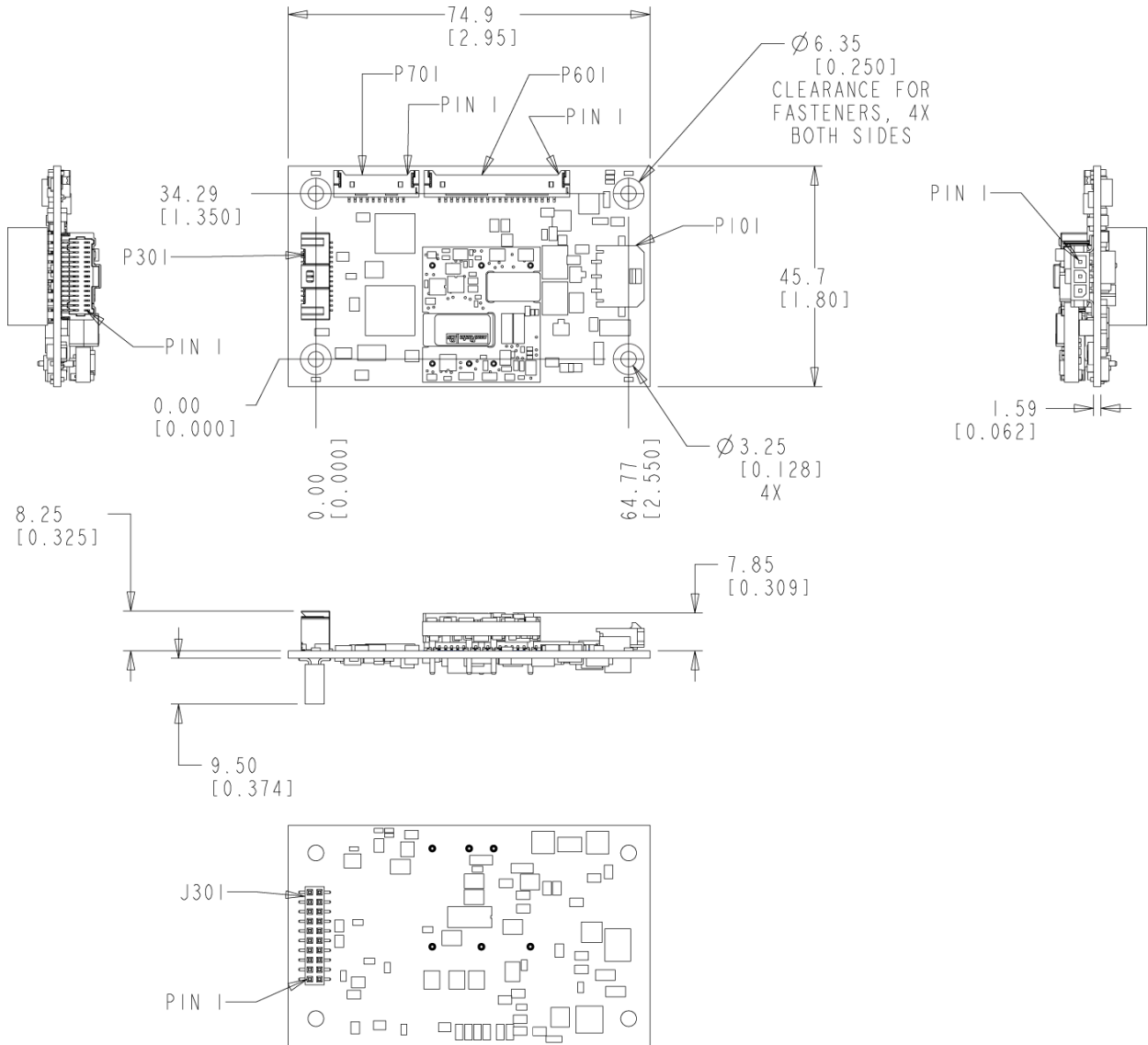
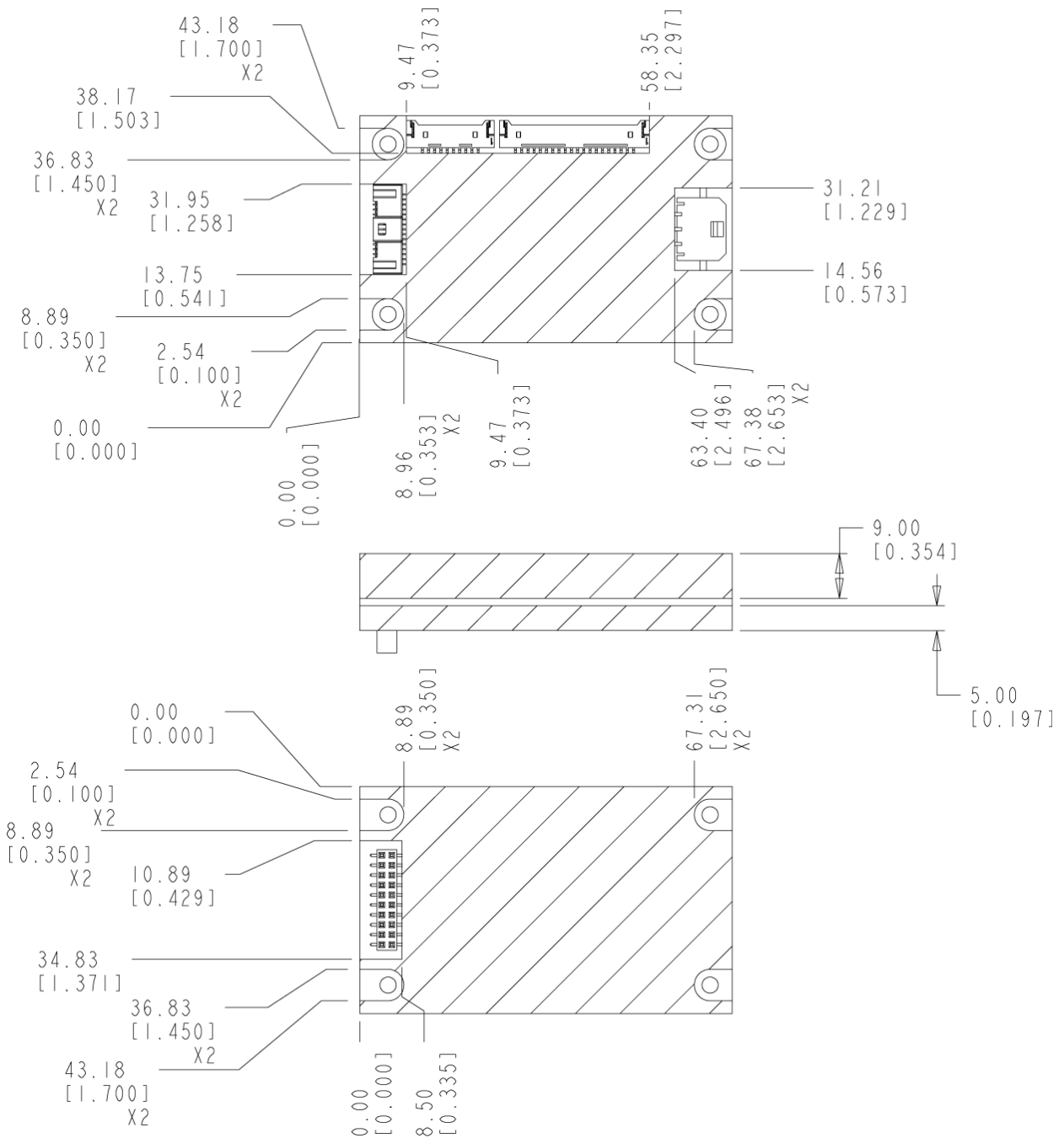


Figure 78: MIC Keep-Out Zone



Cross hatched areas indicate "keepout" areas intended for NovAtel circuitry. NovAtel reserves the right to modify components and component placements inside cross hatched keepout zones, while maintaining design, form, fit and function.

A.16.2 MIC Electrical and Environmental**Table 117: MIC Electrical Specifications**

Electrical	
MIC Input Voltage	10 VDC to 30 VDC
Power Consumption ¹	+5 VDC @ 1 Amp for IMU +3.3 VDC @ 1 Amp for IMU +15 VDC @ 0.5 Amp for IMU -15 VDC @ 0.08 Amp for IMU +3.3 VDC @ 0.6 Amp for OEM719
IMU Data Interfaces	UART and SDLC over RS-422

Table 118: MIC Electrical and Environmental Specifications

Environmental	
Operating Temperature	-40°C to +75°C (-40°F to 167°F)
Storage Temperature	-55°C to +90°C (-67°F to 194°F)
Random Vibe	MIL-STD 810G (Cat 24, 7.7 g RMS)
Sine Vibe	IEC 60068-2-6
Bump	IEC 68-2-29 (25 g)
Shock	MIL-STD-810G (40 g)

A.16.3 MIC Connectors**Table 119: MIC Connectors**

Connector	Description	Part Number	Mating Connector Part number
J301	20-pin OEM719 mating connector	501189-3010 Molex Electronics	Connects only to OEM719 receiver.

¹Sample system power consumption: 5.7 W when powering an HG1900 IMU and OEM719 receiver, in board stack configuration, from VIN=15 VDC at +25°C.

Connector	Description	Part Number	Mating Connector Part number
P101	3-pin locking power connector	43650-0313 Molex Electronics	43645-0300 Molex Electronics
P301	30-pin locking communication connector	501571-3007 Molex Electronics	501189-3010 Molex Electronics
P601	20-pin locking IMU connector for Honeywell and Sensoror IMUs	53780-2070 Molex Electronics	51146-2000 Molex Electronics
P701	10-pin locking IMU connector for ADIS IMUs	53780-1070 Molex Electronics	51146-1000 Molex Electronics

Table 120: Pinouts for Power Connector (P101)

Pin	Signal	Type	Description	Comments
1	VIN+	Power	Power input	+10 VDC to +30 VDC
2	VIN-	Power	Power return	Connect to negative terminal of battery
3	GND	Power	Chassis ground	

Table 121: Pinouts for User Interface Connector (P301)

Pin	Signal	Type	Description	Comments
1	N/C			
2	N/C			
3	LED3	Output	Status LED 3 / Self-test	
4	LED2	Output	Status LED 2 / GPS Time Status	
5	DGND	Power	Digital ground	

¹All signal I/O with the exception of USB port are at LVCMOS levels.

Pin	Signal	Type	Description	Comments
6	LED1	Output	Status LED 1 / IMU Data Status	
7	Reserved	N/A	Leave as no connect	
8	DGND	Power	Digital ground	
9	Reserved	N/A	Leave as no connect	
10	Reserved	N/A	Leave as no connect	
11	N/C	N/A		
12	N/C	N/A		
13	USB D-	Bidirectional	USB interface data (-)	Only available in board stackup with OEM719 In standalone, no connect
14	USB D+/ COM3 RX 2 3	Bidirectional	USB interface data (+)/ COM3 receive data	Only available in board stackup with OEM719 In standalone, no connect
15	RESETIN	Input	OEM719 reset in	Only available in board stackup with OEM719 In standalone, no connect
16	VARF/ CAN1 RX 4	Output/ Input	Variable frequency output/ CAN1 receive data	Only available in board stackup with OEM719 In standalone, no connect
17	EVENT2/ CAN1 TX 5	Input/ Output	Event2 input/ CAN1 transmit data	Only available in board stackup with OEM719 In standalone, no connect

¹All signal I/O with the exception of USB port are at LVCMOS levels.

²The USB port is enabled by default and the COM3 port is disabled by default. If you enable the COM3 port, the USB port is disabled.

³To switch to COM3 send the following commands:

```
MARKCONTROL mark1 disable
INTERFACEMODE com3 novatel novatel
```

⁴The VARF output is enabled by default and the CAN1RX input is disabled by default. If you disable VARF, the CAN1RX input is enabled.

⁵The Event2 input is enabled by default and the CAN1TX output is disabled by default. If you disable EVENT2, the CAN1TX output is enabled.

Pin	Signal	Type	Description	Comments
18	CAN2 RX	Input	CAN2 receive data	Only available in board stackup with OEM719 In standalone, no connect
19	EVENT1/ COM3 TX 3 2	Input	Event1 input/ COM3 transmit data	Only available in board stackup with OEM719 In standalone, no connect
20	DGND	Power	Digital ground	
21	MIC TX	Output		In board stackup with OEM719, this pin is for firmware download In standalone use, this pin can be used for either firmware download and/or for IMU data communication to a SPAN receiver
22	MIC RX	Input		In board stackup with OEM719, this pin is for firmware download In standalone use, this pin can be used for either firmware download and/or for IMU data communication to a SPAN receiver
23	DGND	Power		
24	USER_ TXD2	Output		In board stackup with OEM719, this is the access to the OEM719 COM2 port In standalone, no connect
25	USER_ RXD2	Input		In board stackup with OEM719, this is the access to the OEM719 COM2 port In standalone, no connect
26	DGND	Power	Digital ground	
27	PV	Output	Access to OEM719 position valid	Only available in board stackup with OEM719 In standalone, no connect
28	DGND	Power	Digital ground	
29	1PPS	Output	Access to OEM719 1PPS	Only available in board stackup with OEM719 In standalone, no connect
30	CAN2 TX	Output	CAN2 transmit data	Only available in board stackup with OEM719 In standalone, no connect

¹All signal I/O with the exception of USB port are at LVCMOS levels.

²The Event1 input is enabled by default and the COM3 port is disabled by default. If you enable the COM3 port, the Event1 input is disabled.

Table 122: Pinouts for IMU Connector (P601)

Pin	Signal	Type	Description	Comments
1	GND		Chassis ground	
2	GND		Chassis ground	
3	15V	Output Power	Positive 15 VDC supply	Enabled/disabled depending on the IMU type detected
4	15V	Output Power	Positive 15 VDC supply	Enabled/disabled depending on the IMU type detected
5	-15V	Output Power	Negative 15 VDC supply	Enabled/disabled depending on the IMU type detected
6	DGND		Digital ground	Enabled/disabled depending on the IMU type detected
7	DGND		Digital ground	Enabled/disabled depending on the IMU type detected
8	IMU VDD	Output Power	Positive voltage supply for IMU logic circuits	IMU_VDD can be +3.3 VDC or +5 VDC depending on the IMU type detected
9	IMU VDD	Output Power	Positive voltage supply for IMU logic circuits	
10	DGND	Power	Digital ground	
11	Tx Data+	Output	Serial data out+	Non-inverting
12	Tx Data-	Output	Serial data out-	Inverting
13	RX Data+	Input	Serial data in+	Non-inverting RS-422 data input
14	RX Data-	Input	Serial data in-	Inverting RS-422 data input
15	CLK+	Bidirectional	Serial data clock+	Non-inverting portion of RS-422 link
16	CLK-	Bidirectional	Serial data clock-	Inverting portion of RS-422 link
17	IMU DAS	Bidirectional	Data acquisition signal	Provides synchronization for IMU data (LVCMOS level)
18	IMUTYPE0	Input	detect IMU type	LVCMOS level, not 5V tolerant
19	IMUTYPE1	Input	detect IMU type	LVCMOS level, not 5V tolerant
20	IMUTYPE2	Input	detect IMU type	LVCMOS level, not 5V tolerant

¹All signal I/O are at LVCMOS levels.

Table 123: Pinouts for IMU Connector (P701)

Pin	Signal	Type	Description	Comments
1	IMU_VDD	Output Power	Positive voltage supply for IMU logic circuits	IMU_VDD must be +3.3 VDC
2	IMU_VDD	Output Power	Positive voltage supply for IMU logic circuits	
3	SPI_NSS		Slave Select	LVCMOS level, not 5V tolerant
4	SPI_SCK	Output	Serial Clock	LVCMOS level, not 5V tolerant
5	DGND		Digital Ground	
6	SPI_MOSI	Output	Master Output / Slave Input	LVCMOS level, not 5V tolerant
7	SPI_MISO	Input	Master Input / Slave Output	LVCMOS level, not 5V tolerant
8	DGND		Digital Ground	
9	IMU_DIO1	Bidirectional		LVCMOS level, not 5V tolerant
10	IMU_DIO2	Bidirectional		LVCMOS level, not 5V tolerant

Table 124: MIC LED Indicator Drivers

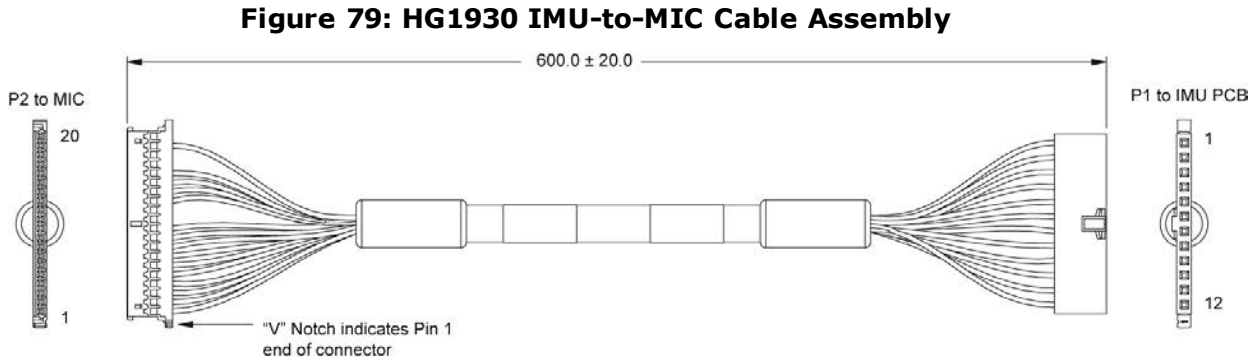
Board State	Status LED 1	Status LED 2	Status LED 3
Bootup	Toggles at 2 Hz Self-test	Off	On
Normal Operation	On	Toggles at 2 Hz GPS Time	Toggles at 2 Hz IMU Data
No IMU Connected	Toggles at 1 Hz Error	Toggles at 2 Hz GPS Time	Toggles at 1 Hz Error



When the MIC boots up, it requires approximately 10 seconds to perform a self-test. If a software update has been performed, the board can take up to 70 seconds at startup to complete the reprogramming.

A.16.4 HG1930 IMU-to-MIC Cable Assembly

The NovAtel part number for the HG1930 IMU-to-MIC interface cable is 01018827 (*Figure 79: HG1930 IMU-to-MIC Cable Assembly* below). This cable provides power to the IMU and enables communication between the MIC and the IMU.



The dimensions in this drawing are in millimetres.

Table 125: HG1930 IMU-to-MIC Cable Assembly

P1 IMU Cable End (FCI-MINITEK)	P2 MIC Cable End
Pin	Pin
1	15
2	16
3	13
4	14
5	8
7	7
6	9
8	10
11	3
	4
12	6
	19
9	5
10	1
	2

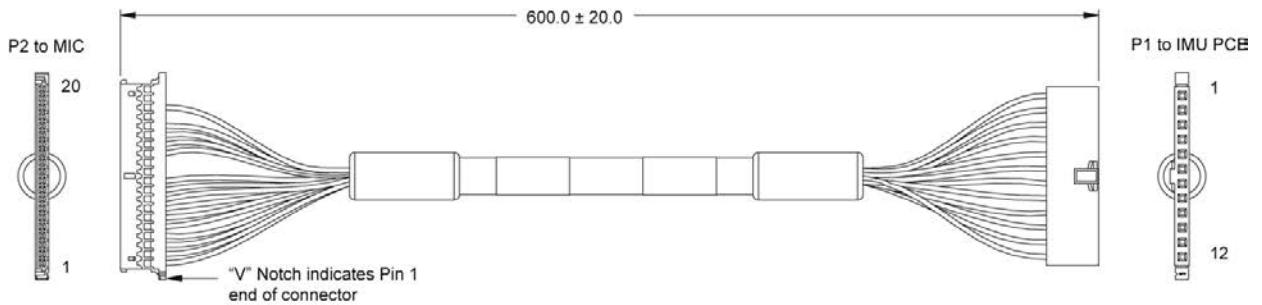


For more information, refer to the IMU documentation provided by Honeywell.

A.16.5 HG1700 and HG1900 IMU-to-MIC Cable Assembly

The NovAtel part number for the HG1700 and HG1900 IMU-to-MIC interface cable is 01018828 (Figure 80: HG1700 and HG1900 IMU-to-MIC Cable Assembly below). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 80: HG1700 and HG1900 IMU-to-MIC Cable Assembly



The dimensions in this drawing are in millimetres.

Table 126: HG1700 and HG1900 IMU-to-MIC Cable Assembly

P1 IMU Cable End (FCI-MINITEK)		P2 MIC Cable End	
Pin		Pin	
1		15	
2		16	
3		13	
4		14	
5		8	
7		7	
6		9	
8		10	
11		3	
		4	
12		6	
		18	

P1 IMU Cable End (FCI-MINITEK)	P2 MIC Cable End
Pin	Pin
9	5
10	1
	2



For more information, refer to the IMU documentation provided by Honeywell.

A.17 UIC - Universal IMU Controller

Table 127: UIC Physical Specifications

Physical	
UIC Size	100 mm x 113 mm x 17.54 mm (3.94" x 4.45" x 0.69")
UIC Weight	125 g (0.28 lb)

See the following sections for more information about the UIC.

- *UIC Mechanical Drawings* on the next page
- *UIC Electrical and Environmental* on page 199
- *UIC Connectors* on page 199

A.17.1 UIC Mechanical Drawings


 The dimensions in the following drawings are in millimetres.

Figure 81: UIC Dimensions and Keep Out Zones

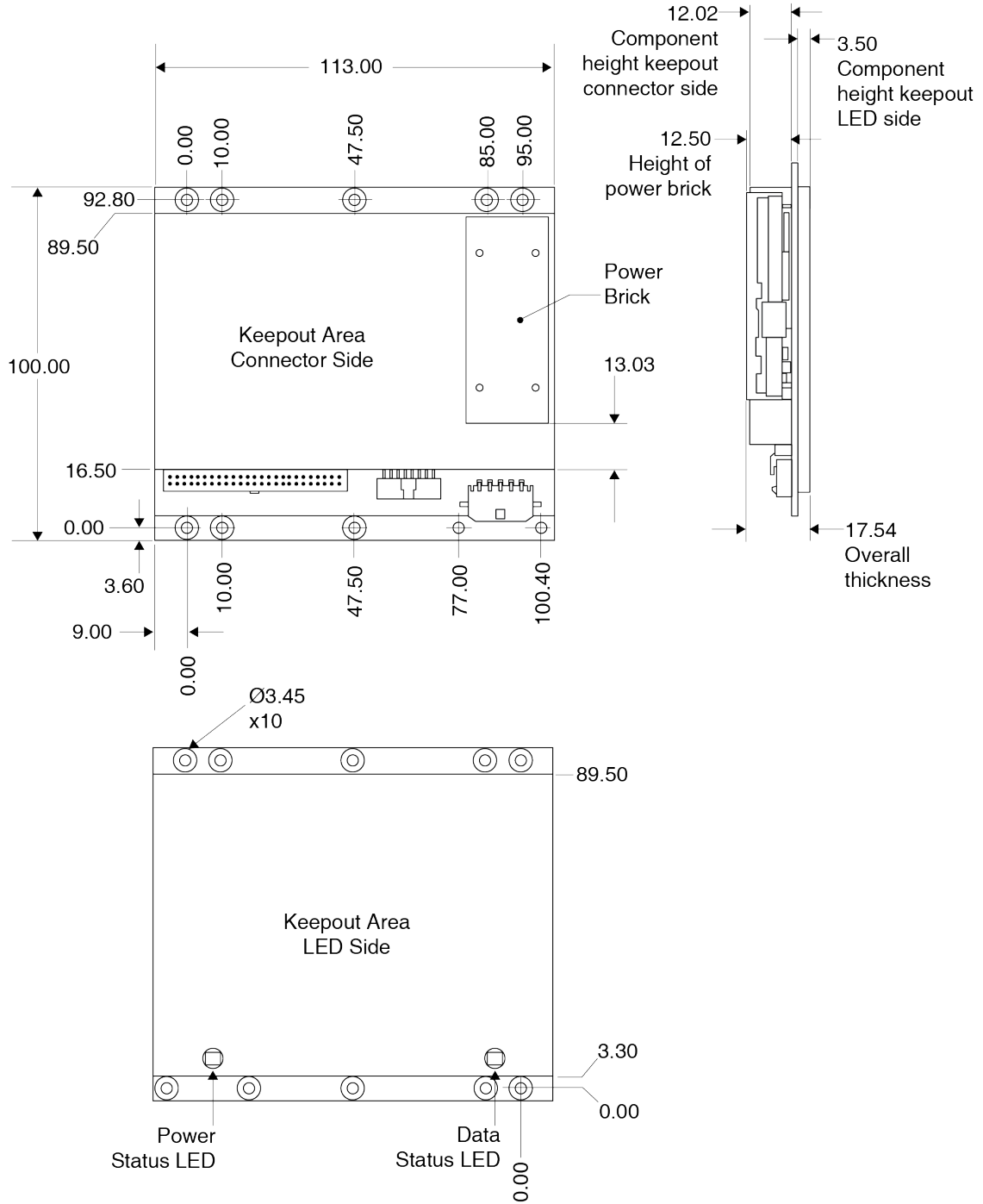
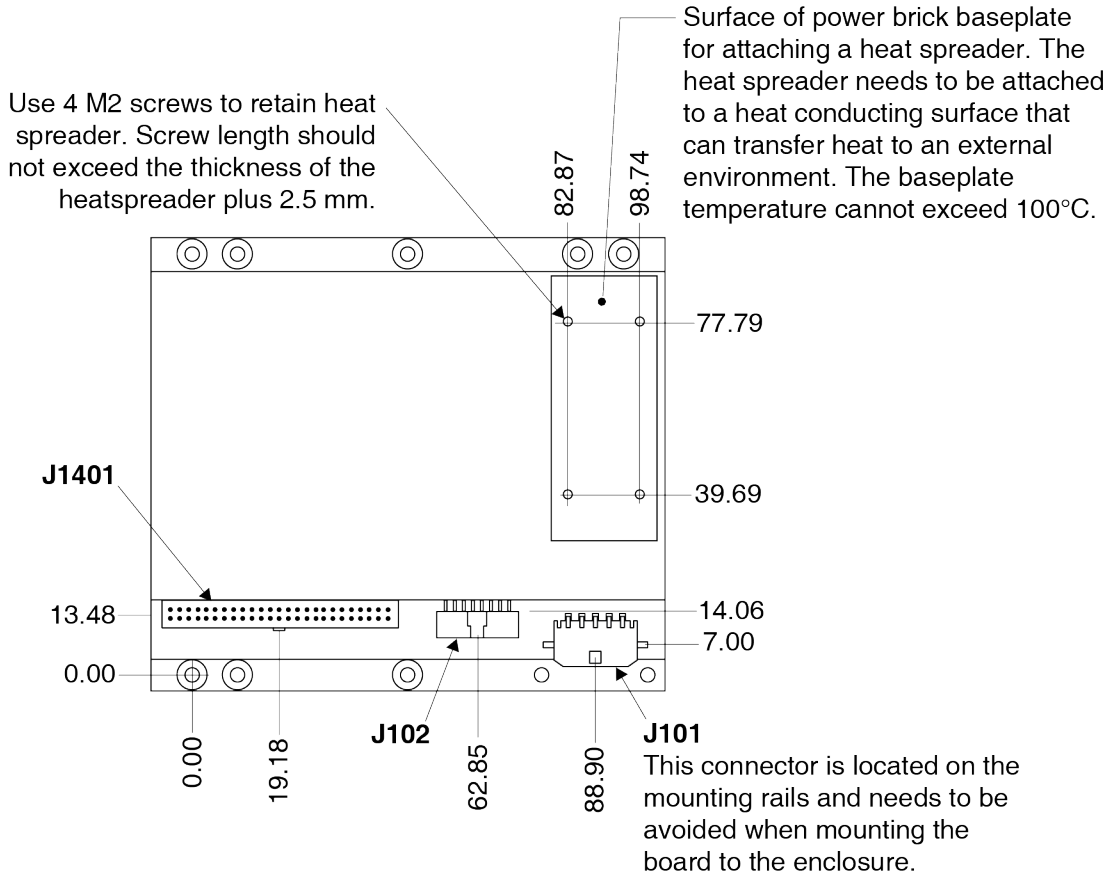
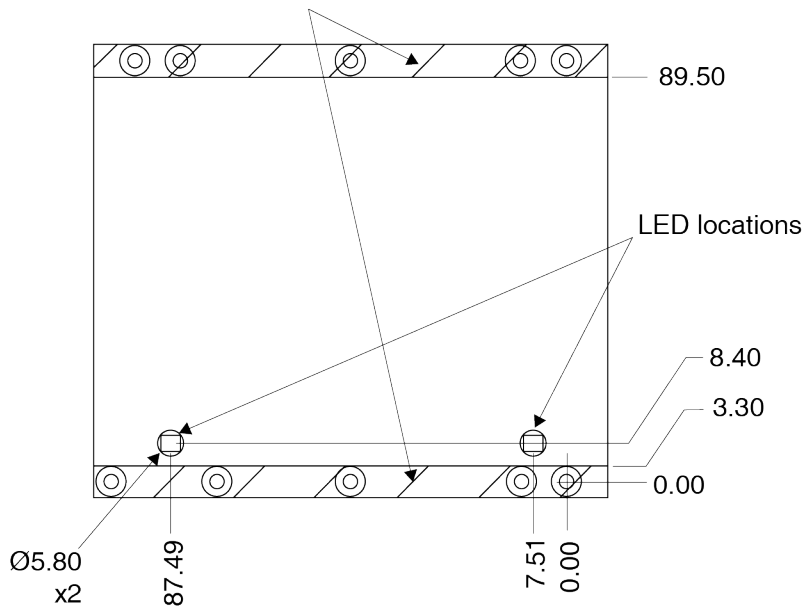


Figure 82: UIC Connectors, LEDs and Heat Sink Details



Cross hatching indicates mounting rail on both sides with noted exception for J101 connector.



A.17.2 UIC Electrical and Environmental**Table 128: UIC Electrical Specifications**

Electrical	
UIC Input Voltage	10 VDC-34 VDC
Power Consumption	4 W ^a
IMU Data Interfaces	UART and SDLC over RS-422

Table 129: UIC Environmental Specifications

Environmental	
Operating Temperature	-40°C to +75°C (-40°F to 167°F)
Storage Temperature	-55°C to +90°C (-67°F to 194°F)
Random Vibe	MIL-STD 810G (Cat 24, 7.7 g RMS)
Sine Vibe	IEC 60068-2-6
Bump	IEC 68-2-29 (25 g)
Shock	MIL-STD-810G (40 g)

A.17.3 UIC Connectors**Table 130: UIC Connectors**

Connector	Description	Part Number	Mating Connector Part number
J101	5-pin UIC power connector ^b	43650-0513 Molex Electronics	43645-0500 Molex Electronics
J102	16-pin UIC to receiver communication connector ^c	98464-G61-16LF FCI Electronics	90311-016LF FCI Electronics
J1401	50-pin UIC to IMU communication connector	LTMM-125-02-L-D (Samtec)	SQT-125-01-L-D (Samtec)

^aAt 12 VDC input.

^bA filter module (similar to Delta FL 75L07) in series with the power cable maybe needed to pass conducted emission.

^cA tubular ferrite bead (similar to Laird Technologies 28B0375-300) maybe attached to the data cable to reduce radiated emissions.

Table 131: Pinouts for Power Connector (J101)

Pin	Signal	Type	Description	Comments
1	VIN+	Power	Power input	+10 VDC to +34 VDC
2	VIN+	Power	Power input	+10 VDC to +34 VDC
3	VIN-	Power	Power return	Connect to negative terminal of battery
4	VIN-	Power	Power return	Connect to negative terminal of battery
5	GND	Power	Chassis ground	

Table 132: Pinouts for UIC to Receiver Communications Connector (J102)

Pin	Signal	Type	Description	Comments
A1	UIC_RX+	Input	RS-422 serial data in+	RS-422 serial port for UIC to receiver communication
A2	UIC_RX-	Input	RS-422 serial data in-	
A3	UIC_TX+	Output	RS-422 serial data out+	
A4	UIC_TX-	Output	RS-422 serial data out-	
A5	A+	Input	Odometer input A (+)	Connects to the wheel sensor.
A6	A-	Input	Odometer input A (-)	Connects to the wheel sensor.
A7	Reserved			
A8	Reserved			
B1	Reserved			
B2	Reserved			
B3	EVENT_OUT+	Output	Event output (+)	
B4	EVENT_OUT-	Output	Event output (-)	
B5	B+	Input	Odometer input B (+)	Connects to the wheel sensor.
B6	B-	Input	Odometer input B (-)	Connects to the wheel sensor.
B7	Reserved (do not connect)			
B8	CGND	Power	Chassis ground	

^aAll signal I/O are at LVCMOS levels (not 5V tolerant).

Table 133: Pinouts for UIC to IMU Communications Connector (J1401)

Pin	Signal	Type	Description
1	3.3V	Output Power	Positive 3.3 VDC supply
2	3.3V	Output Power	Positive 3.3 VDC supply
3	3.3V	Output Power	Positive 3.3 VDC supply
4	GND	Power	Digital ground
5	GND	Power	Digital ground
6	GND	Power	Digital ground
7	15V	Output Power	Positive 15 VDC supply
8	GND	Power	Digital ground
9	-15V	Output Power	Negative 15 VDC supply
10	GND	Power	Digital ground
11	NSS		SPI Slave Select
12	PWRDOWNx	Output	Power down warning
13	SCK	Output	SPI Serial Clock
14	RESETIMUx	Output	Reset IMU
15	GND	Power	Digital ground
16	GND	Power	Digital ground
17	MISO	Input	SPI Master Input / Slave Output
18	NOGOx		
19	MOSI	Output	SPI Master Output / Slave Input
20	DIO2		
21	GND	Power	Digital ground
22	GND	Power	Digital ground
23	IMU_TYPE0	Input	Detect IMU type 0
24	IMU_EVENT_IN		
25	IMU_TYPE1	Input	Detect IMU type 1
26	IMU_EVENT_OUT		

^aAll signal I/O are at LVCMOS levels (not 5V tolerant).

Pin	Signal	Type	Description
27	IMU_TYPE2	Input	Detect IMU type 2
28	GND	Power	Digital ground
29	IMU_TYPE3	Input	Detect IMU type 3
30	TXC-		
31	IMU_DATA_OUT1-		
32	TXC+		
33	IMU_DATA_OUT1+		
34	SYNC-		
35	GND	Power	Digital ground
36	SYNC+		
37	IMU_DATA_OUT2-		
38	TXD-		
39	IMU_DATA_OUT2+		
40	TXD+		
41	GND	Power	Digital ground
42	GND	Power	Digital ground
43	5.25V	Output Power	Positive 5.25 VDC supply
44	5.25V	Output Power	Positive 5.25 VDC supply
45	GND	Power	Digital ground
46	5.25V	Output Power	Positive 5.25 VDC supply
47	GND	Power	Digital ground
48	GND	Power	Digital ground
49	-5.25V	Output Power	Negative 5.25 VDC supply
50	-5.25V	Output Power	Negative 5.25 VDC supply

A.0.3 HG1900 IMU to UIC Cable Assembly

The NovAtel part number for the HG1900 IMU to UIC interface cable is 01019762 (*Figure 83: OEM-IMU-HG1900 IMU to UIC Cable Assembly* on the next page). This cable provides power to the IMU and enables communication between the MIC and the IMU.

^aAll signal I/O are at LVCMOS levels (not 5V tolerant).

Figure 83: OEM-IMU-HG1900 IMU to UIC Cable Assembly

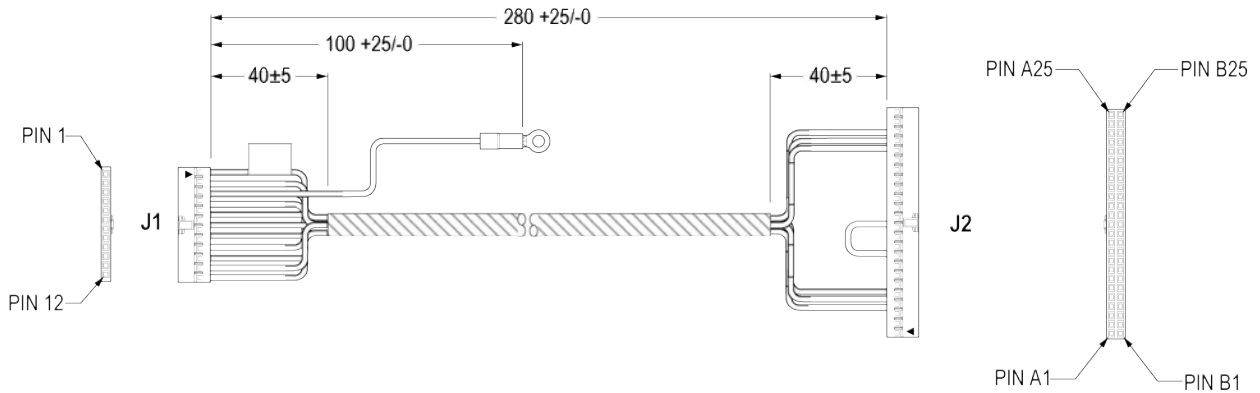


Table 134: OEM-IMU-HG1900 IMU to UIC Cable Pinout

J1 Pins (to HG1900)	J2 Pins (to UIC)
1	A3 B5
2	A4
3	Lug Ring
4	A5
5	A23
6	B21
7	B22
8	A22
9	B19
10	B20
11	A16
12	A17
	A11 to A12

A.0.4 LN200 IMU to UIC Cable Assembly

The NovAtel part number for the LN200 IMU to UIC interface cable is 01019763 (*Figure 84: OEM-IMU-LN200 IMU to UIC Cable Assembly* on the next page). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 84: OEM-IMU-LN200 IMU to UIC Cable Assembly

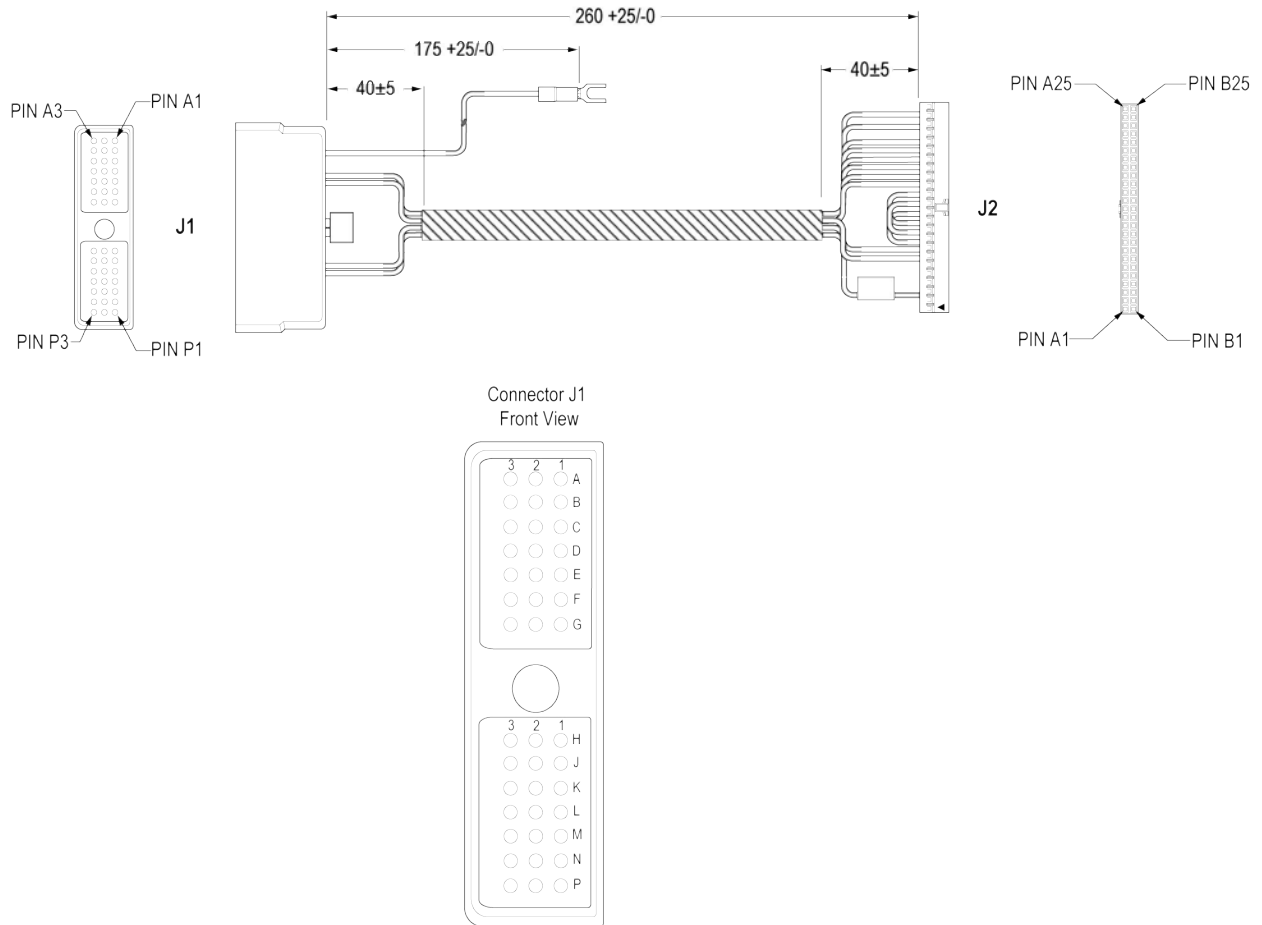


Table 135: OEM-IMU-LN200 IMU to UIC Cable Pinout

J1 Pins (to LN200)	J2 Pins (to UIC)
A2	B19
A3	B15
B1	B20
B2	B16
C1	A3 B14
D1	A24 B24
D2	A21 B21

J1 Pins (to LN200)		J2 Pins (to UIC)
D3		Lug Fork
E1		A22
E2		B22
E3		B23
F3		A4
G2		A5
K1		B4 B5
L2		B18
L3		B17
		A8 to A13
		A11 to 12
		A15 to A18

APPENDIX B HG1700 IMU in Universal Enclosure

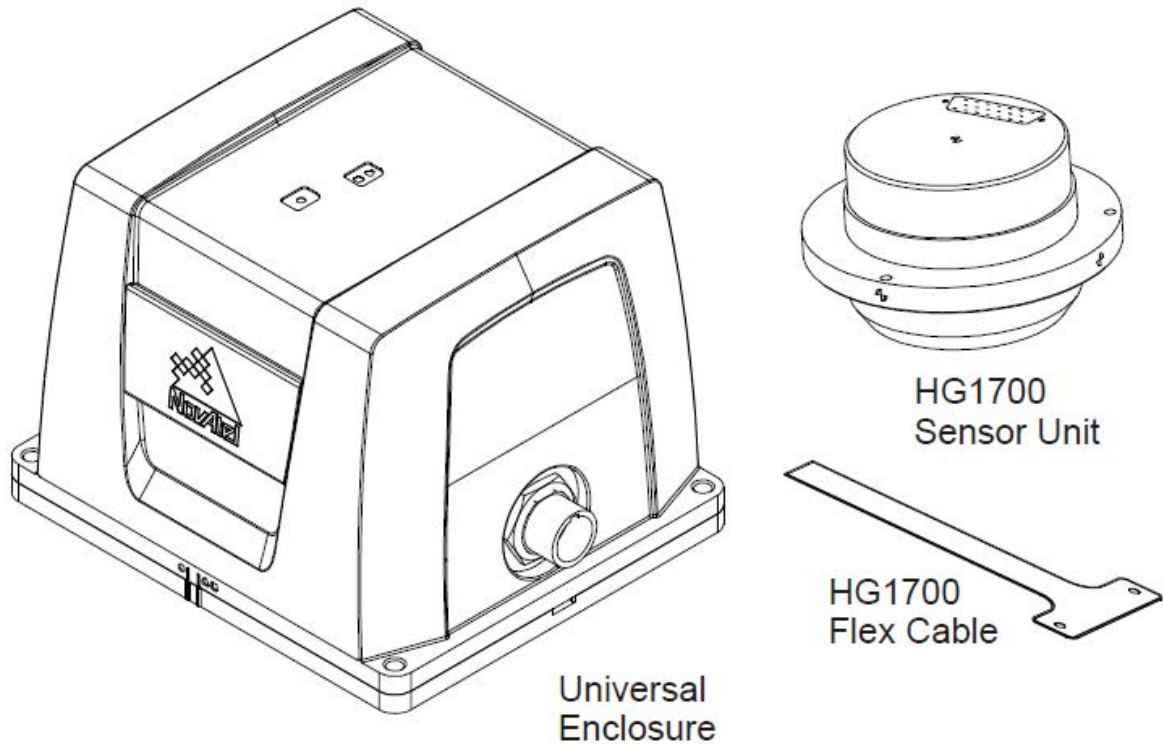


Important! Assemble in accordance with applicable industry standards. Ensure all ESD measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces and the IMU.

The following procedure provides the necessary information to install the HG1700 sensor into the Universal Enclosure (NovAtel part number 01018589), both illustrated below. The steps required for this procedure are:

- Disassemble the Universal Enclosure
- Install the HG1700 Sensor Unit
- Reassemble the Universal Enclosure

Figure 85: Required Parts



Use thread-locking fluid on all fasteners except for the flex cable connectors.



Torque values for all fasteners, including those for the flex cable, are as follows:

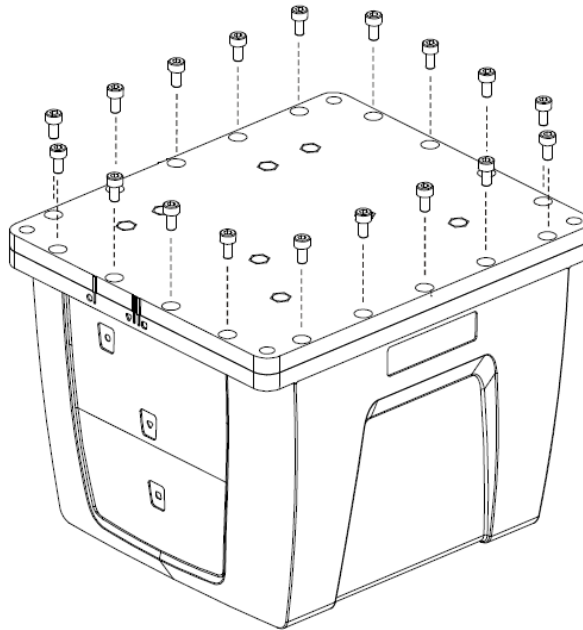
- Size 2-56: 0.20-0.25 N-m (1.8-2.2 lb-in) [28-35 oz/in]
- Size M4: 1.36-1.58 N-m (12.0-14.0 lb-in)
- Size 8-32: 1.55-1.70 N-m (13.7-15.0 lb-in)

B.1 Disassemble the Universal Enclosure

Disassemble the Universal Enclosure as follows:

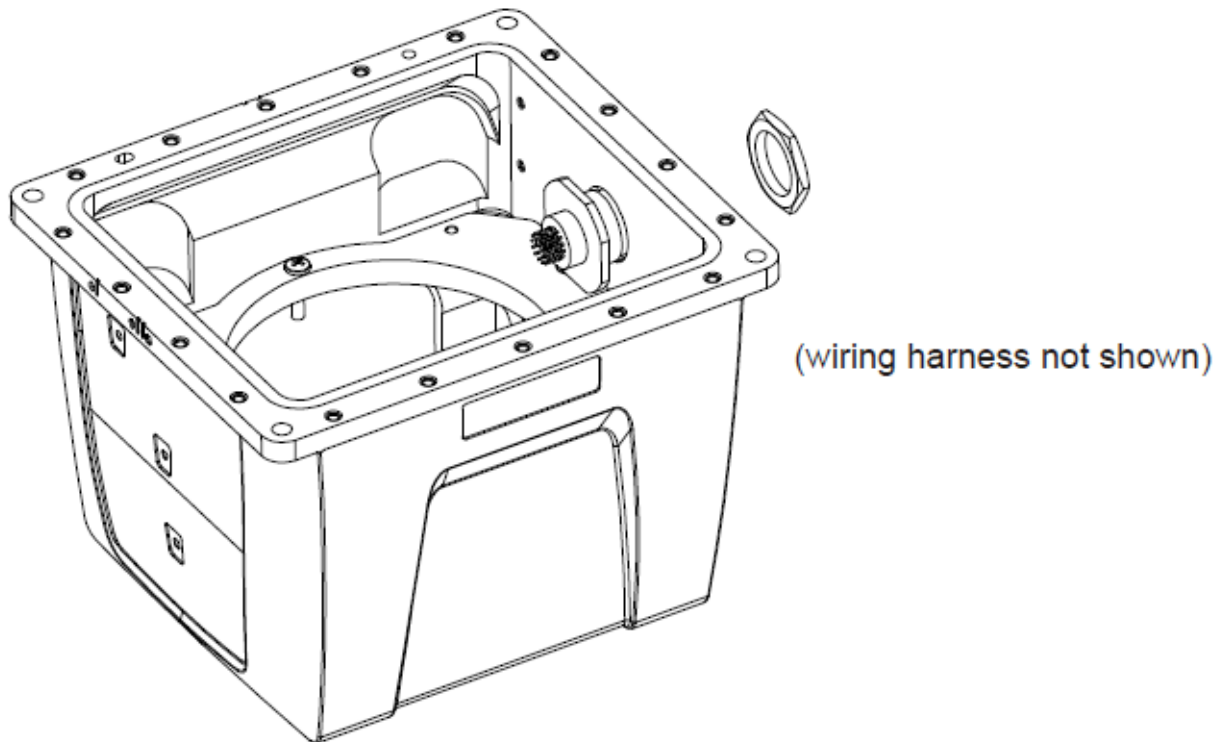
1. Using a 3 mm hex bit, remove the M4 screws (they will be reused) and the base, as shown in *Figure 86: Remove Base* below. Ensure the O-rings come with the base when it is removed, and that they are not damaged.

Figure 86: Remove Base



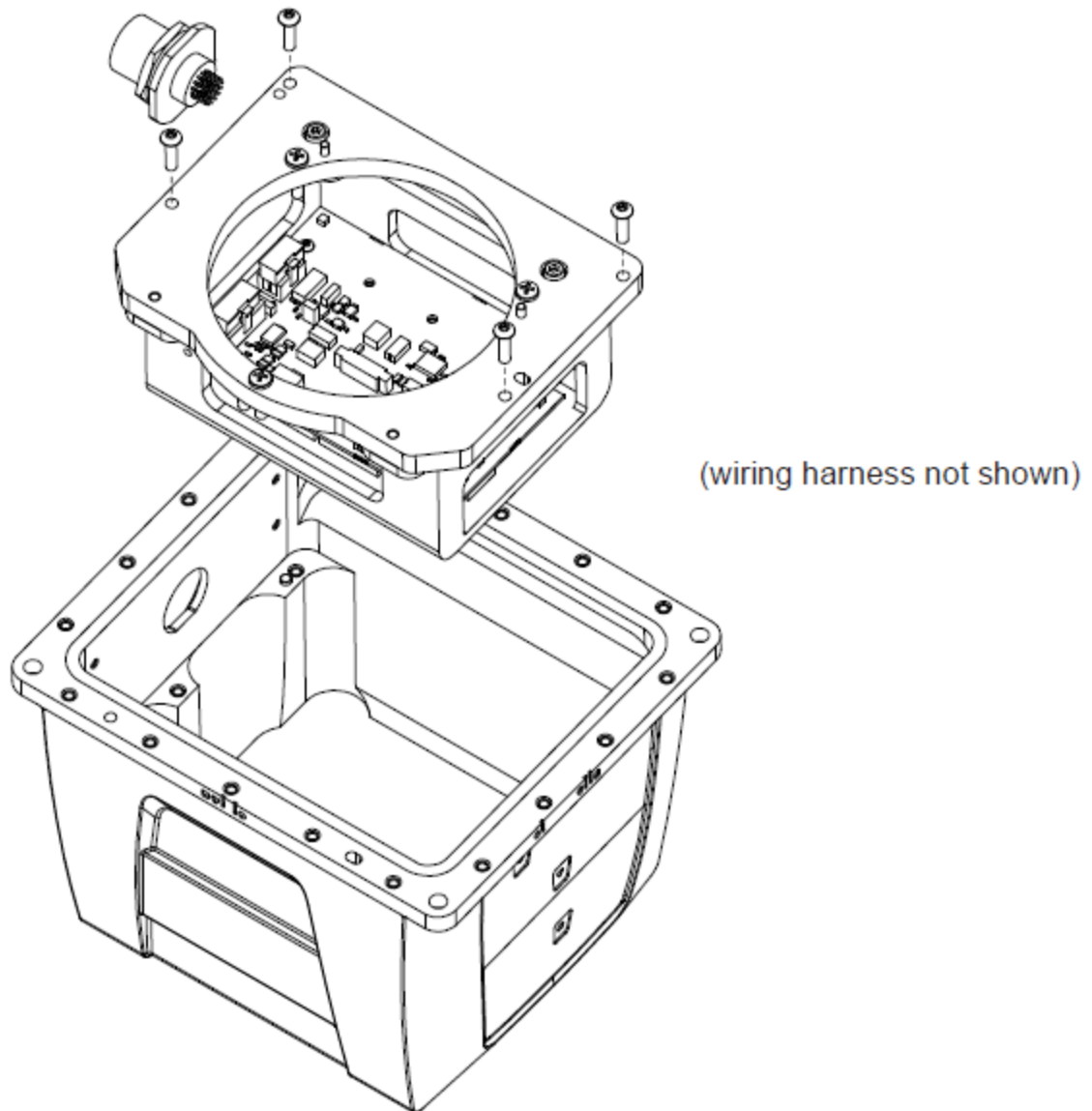
2. Using a 30 mm socket, remove the jam nut and free the wiring harness connector from the body, as shown in *Figure 87: Disconnect Wiring Harness from Enclosure Body* on the next page. Retain the O-ring and the jam nut for reassembly.

Figure 87: Disconnect Wiring Harness from Enclosure Body



3. Using a 2.5 mm hex bit, unscrew the M4 screws and remove the IMU mounting plate, bracket and cable harness, as shown in *Figure 88: Remove IMU Mounting Plate and Bracket* on the next page:

Figure 88: Remove IMU Mounting Plate and Bracket

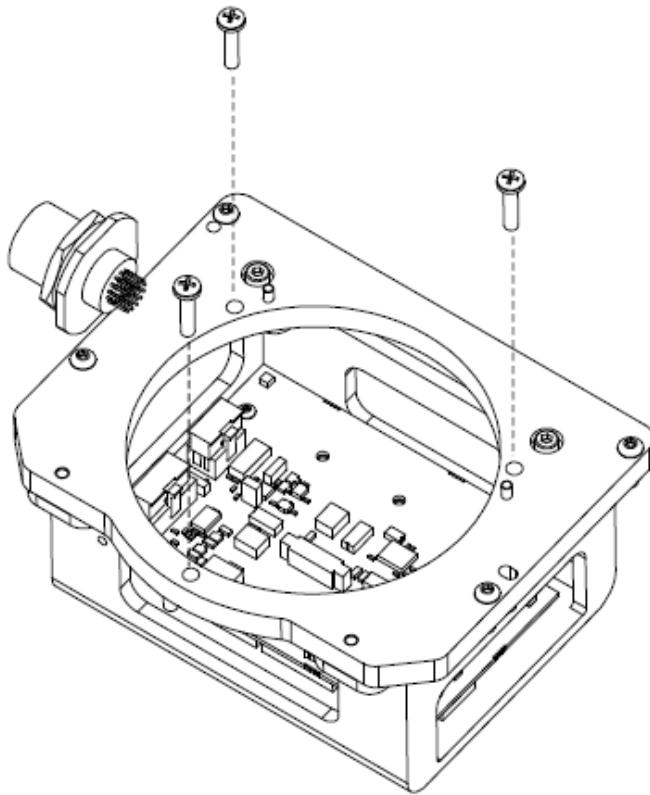


B.2 Install the HG1700 Sensor Unit

To install the HG1700 sensor unit in the Universal Enclosure:

1. Using a Phillips screwdriver, remove the 8-32 IMU mounting screws from the IMU mounting plate, as shown in *Figure 89: Remove IMU Mounting Screws* on the next page.

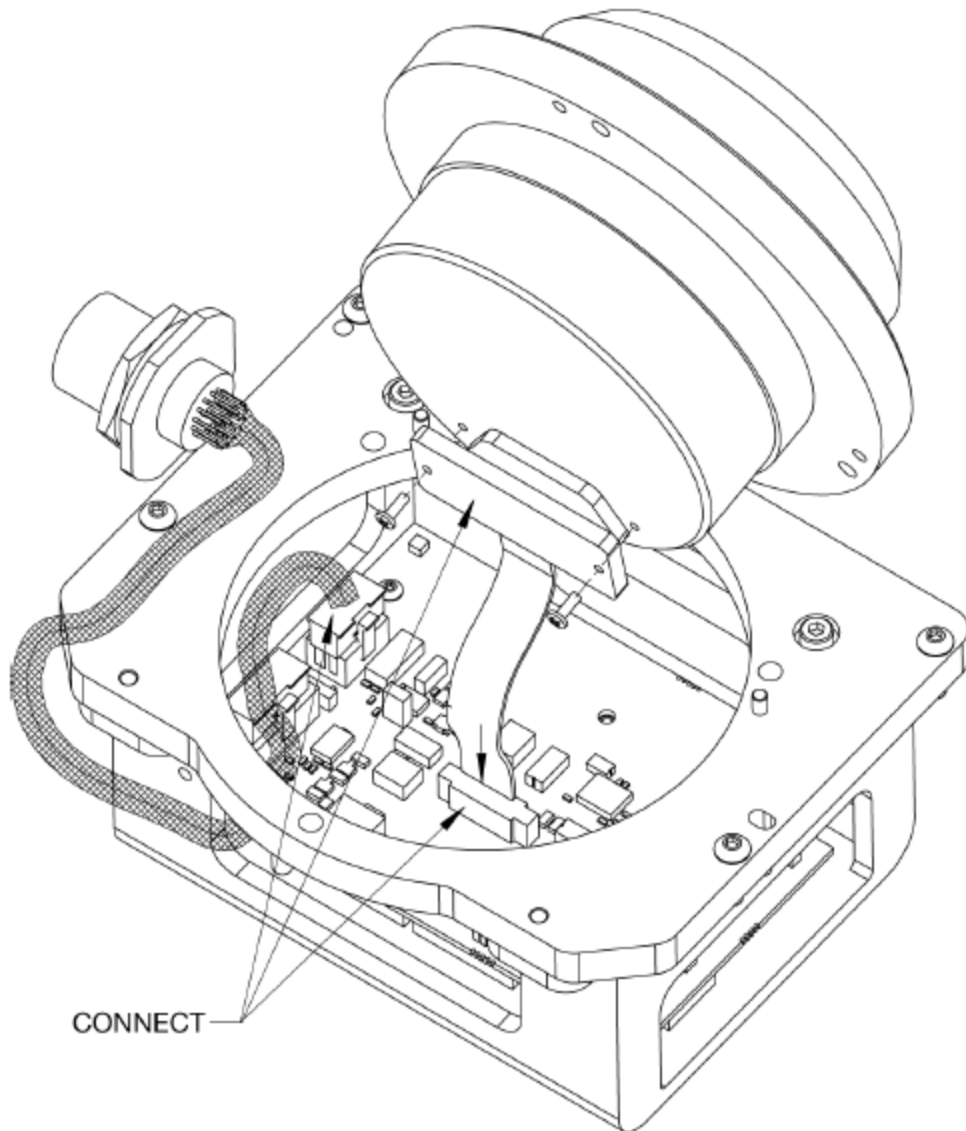
Figure 89: Remove IMU Mounting Screws



(wiring harness not shown)

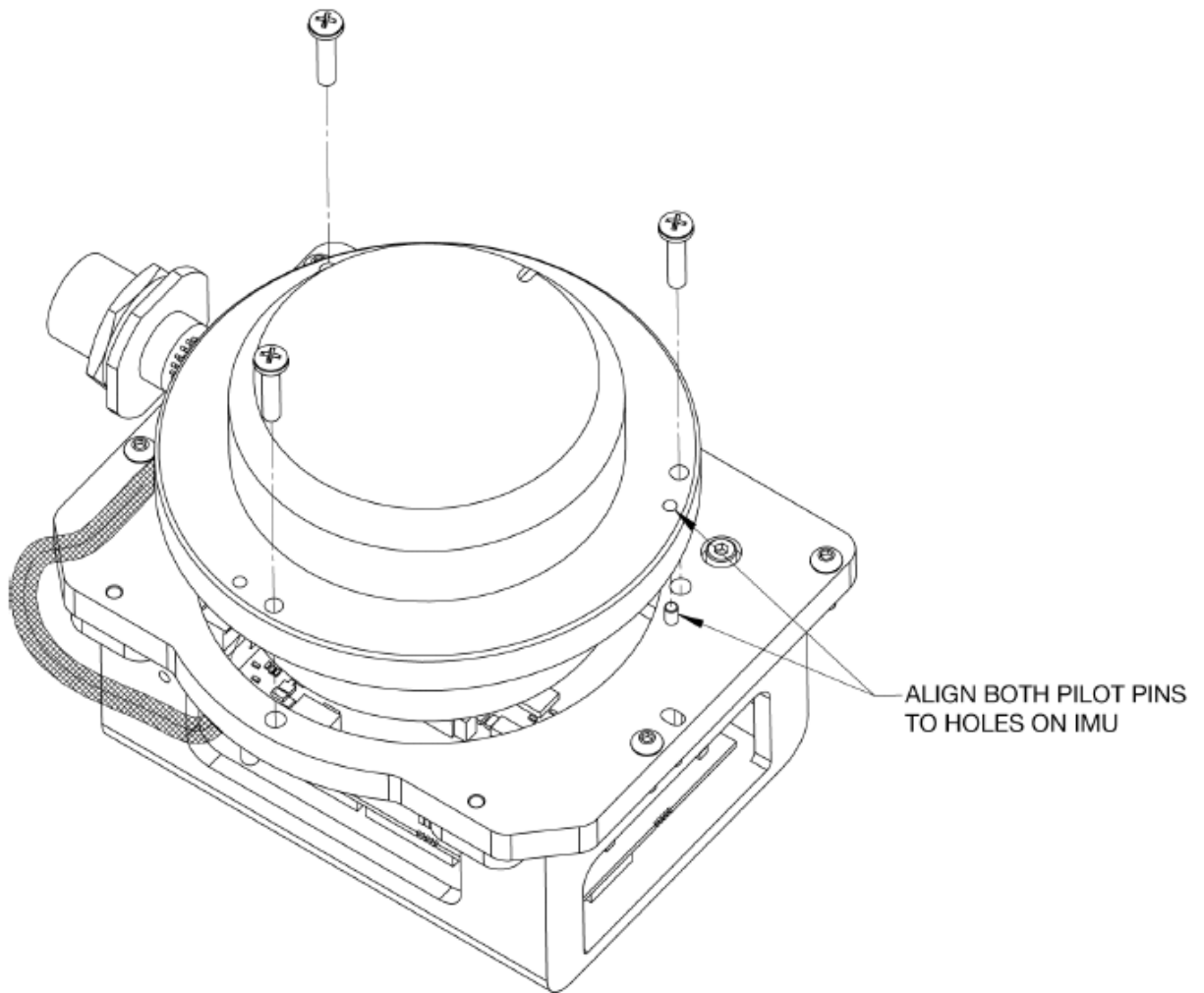
2. Check the connection of the internal cable harness to the board assembly and route as shown in *Figure 90: Connect IMU to IMU Mounting Plate* on the next page. Before you connect the IMU cable harness, make sure the connector on the board assembly is clicked open. Connect the IMU cable harness to the IMU (fasten the 2-56 screws but do not use thread-locking fluid), then connect to the board assembly. Ensure the cable housing latches.

Figure 90: Connect IMU to IMU Mounting Plate

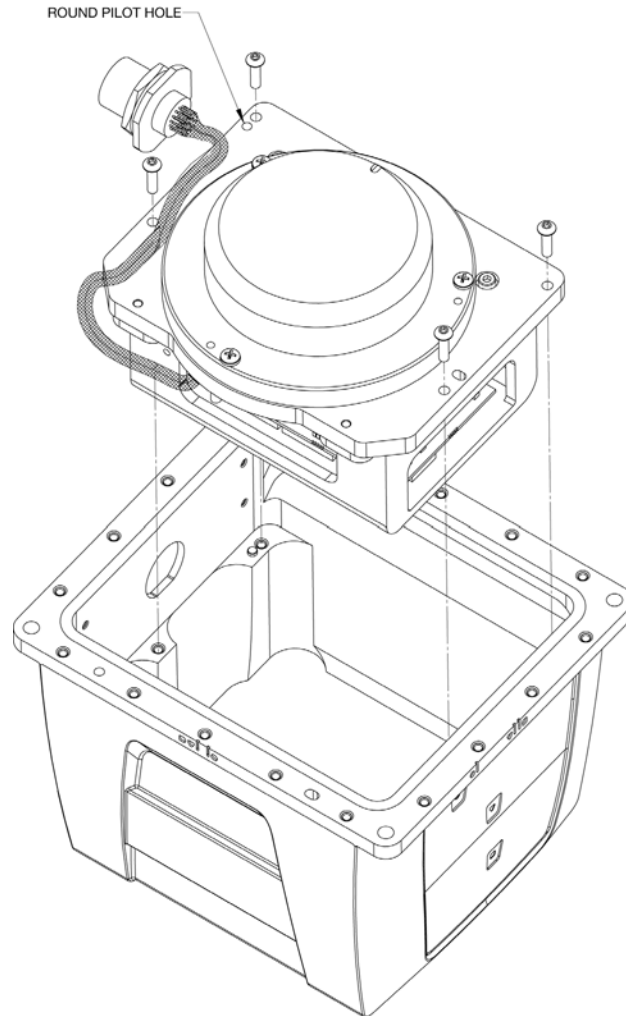


3. Being careful of the connectors and the orientation, align the pilot holes of the IMU with the pilot pins of the mounting plate. Gently place the IMU and mounting plate together, being careful not to pinch the cable harness. Screw the IMU and mounting plate together, using thread-locking fluid on the 8-32 screws, as shown in *Figure 91: Installing IMU to Mounting Plate* on the next page.

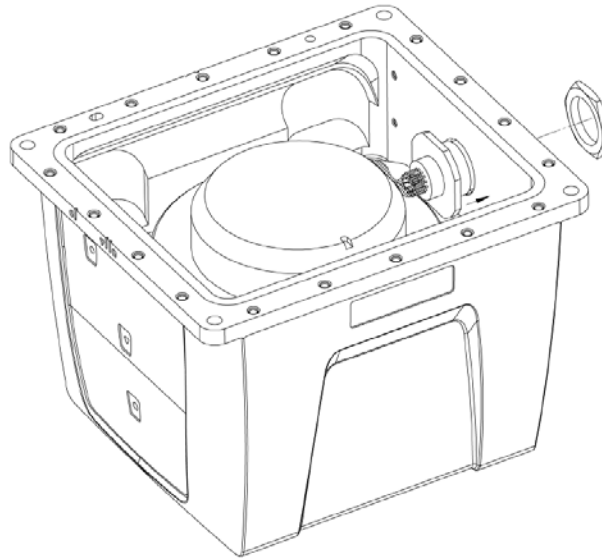
Figure 91: Installing IMU to Mounting Plate



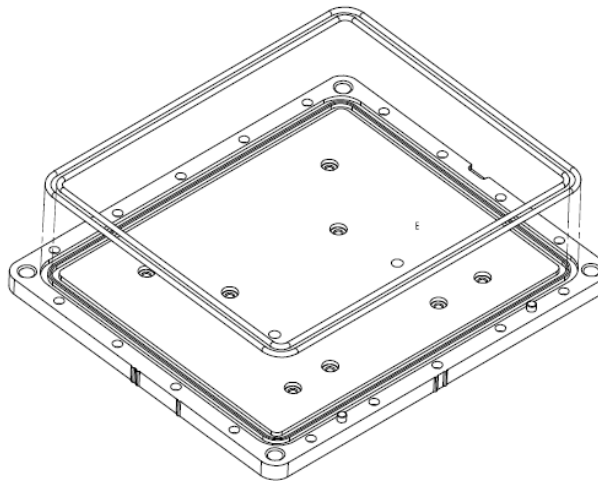
4. Starting with the round pilot hole, shown in *Figure 92: Assemble Into Enclosure Body* on the next page, align the pilot holes of the assembled plate (noting the orientation) with the pilot pins of the enclosure body. Lower the assembly into place, then fasten using thread-locking fluid on the M4 screws.

Figure 92: Assemble Into Enclosure Body

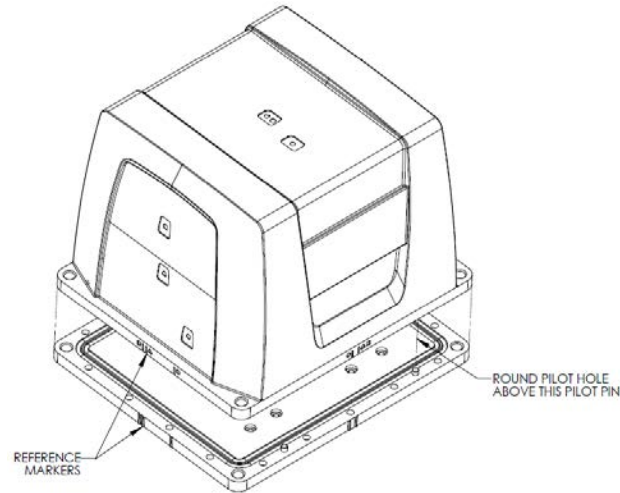
5. Connect the internal cable harness to the enclosure body, as shown in *Figure 93: Fasten Internal Cable Harness* on the next page. During this step, ensure the connector O-ring (supplied with the connector of the internal cable harness) remains flat within the connector's groove, and make sure the groove is clean and free of debris. Fasten the connector to the enclosure body wall using the jam nut supplied with the connector. Apply thread-locking fluid then, with a 30 mm socket, tighten the jam nut to 6.9 N-m (61 lb-in/5.1 lb-ft).

Figure 93: Fasten Internal Cable Harness

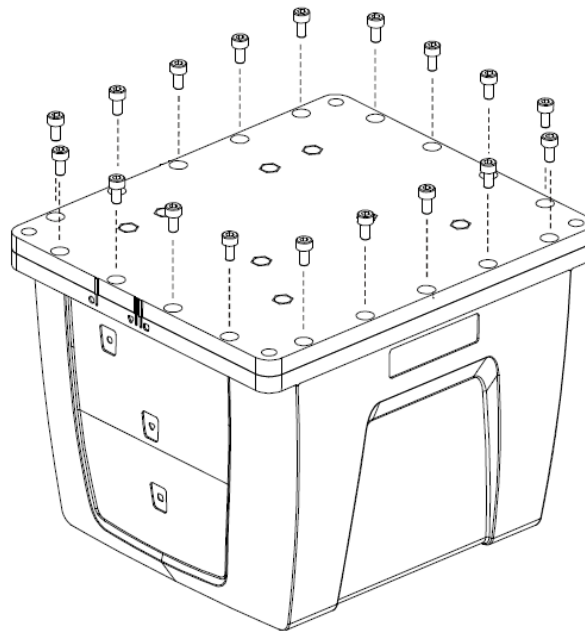
6. Ensure the O-rings are in place. If they are not, as necessary, make sure the grooves of the enclosure base are clean and free of debris, using isopropyl alcohol. As shown in *Figure 94: Install O-rings* below, install the outer environmental and inner EMI O-rings in the enclosure base, being careful not to stretch or twist them. O-rings must remain flat within the grooves during the remainder of the assembly procedure.

Figure 94: Install O-rings

7. Clean the surface of the enclosure body, where it mates with the O-rings, using isopropyl alcohol. As shown in *Figure 95: Install Enclosure Body on the Base* on the next page, align the reference markers and pilot holes/pins of the enclosure body and base. Carefully lower the body onto the base, observing the O-rings and alignment of corners. Press the enclosure body into place, starting with the round pilot hole indicated in *Figure 95: Install Enclosure Body on the Base* on the next page.

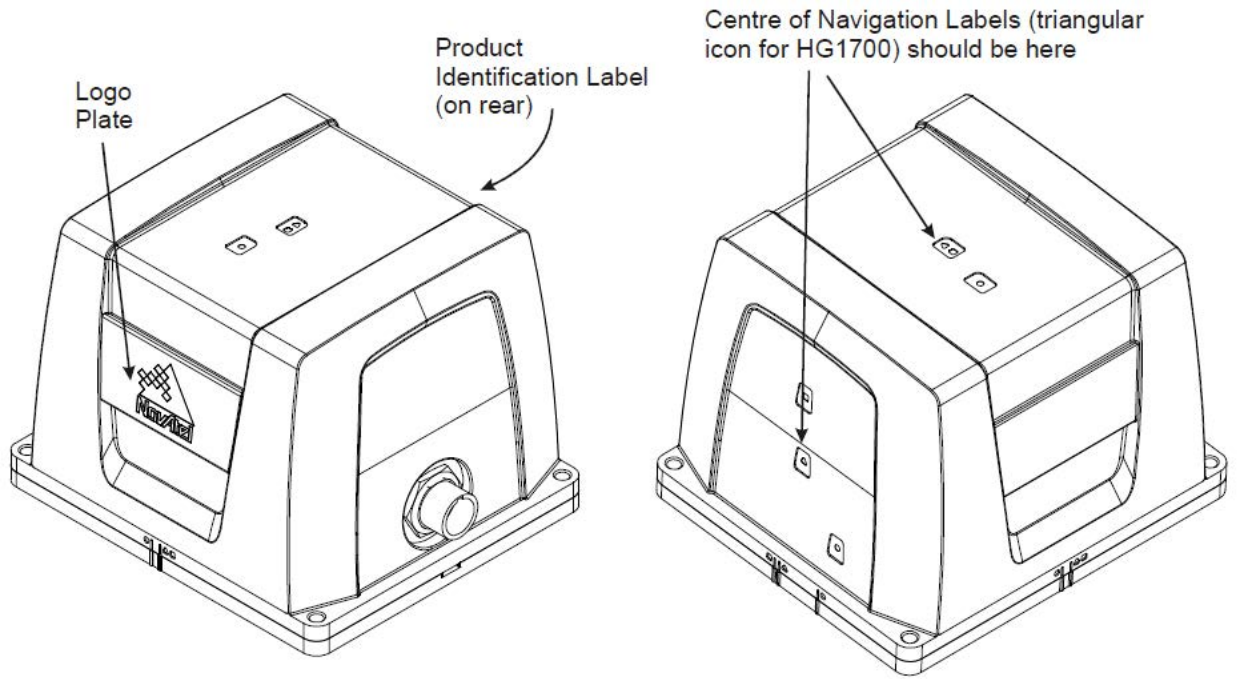
Figure 95: Install Enclosure Body on the Base

8. While squeezing and holding the enclosure body and base together to maintain tight contact, carefully turn the assembly over and place it on its top, as shown in *Figure 96: Screw Enclosure Base to Body* below. Using a 3 mm hex bit, lightly fasten four equally spaced M4 screws to hold the parts together. Apply thread-locking fluid to each screw before inserting. Install the remaining screws in similar fashion. Tighten all screws then check all of them again for tightness. Tighten these screws to 1.36-1.58 N-m (12-14 lb-in). Do not over-tighten.

Figure 96: Screw Enclosure Base to Body

9. Ensure the product identification label, the logo plate and the center of navigation labels are properly affixed and contain the correct information. The final assembled unit will be similar to that shown in *Figure 97: Final Assembly* on the next page.

Figure 97: Final Assembly



APPENDIX C LN-200 IMU in Universal Enclosure

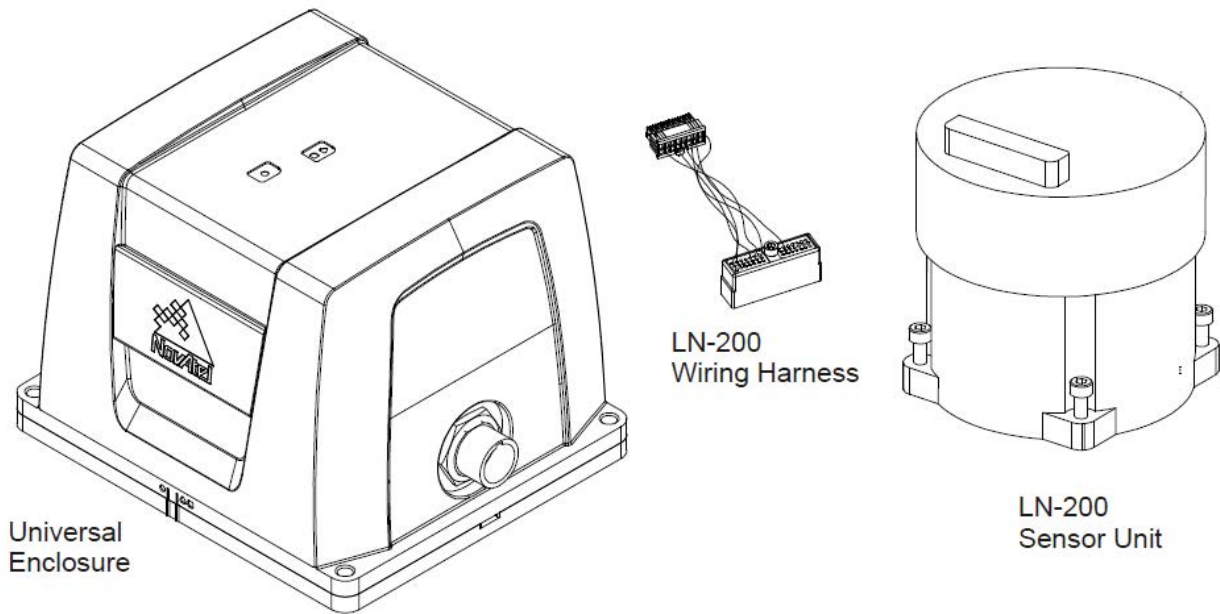


Important! Assemble in accordance with applicable industry standards. Ensure all ESD measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces, and the IMU.

The following procedure provides the necessary information to install the LN-200 sensor into the Universal Enclosure (NovAtel part number 01018590), both illustrated below. The steps required for this procedure are:

- Disassemble the Universal Enclosure
- Install the LN-200 Sensor Unit
- Reassemble the Universal Enclosure

Figure 98: Required Parts



Use thread-locking fluid on all fasteners except for the cable harness connectors.



Torque values for all fasteners, including those for the cable harness screws, are as follows:

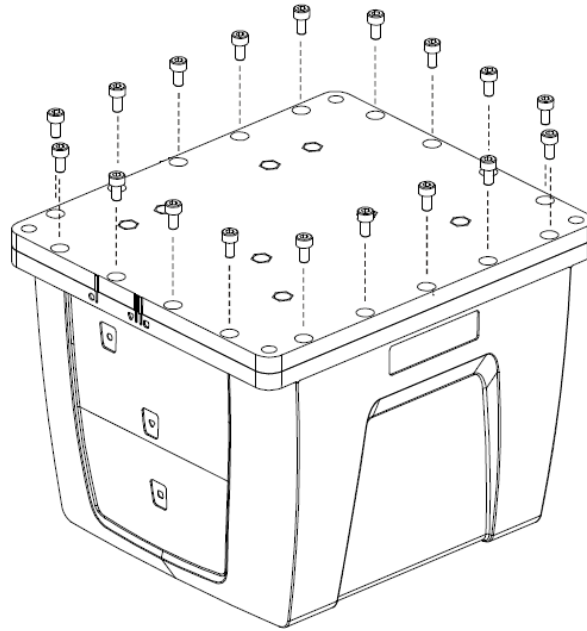
Size 6-32: 0.79-0.90 N-m (7.0-8.0 lb-in)
Size M4: 1.36-1.58 N-m (12.0-14.0 lb-in)

C.1 Disassemble the Universal Enclosure

Disassemble the Universal Enclosure as follows:

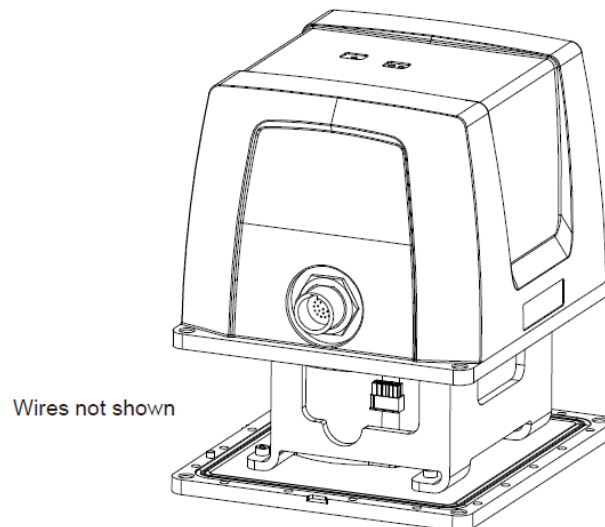
1. Using a 3 mm hex bit, remove the M4 screws (they will be reused) and the base, as shown in *Figure 99: Remove Base* below.

Figure 99: Remove Base

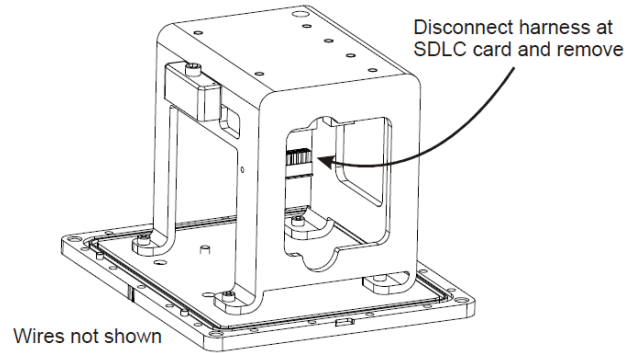


2. While squeezing and holding the assembly tightly together, carefully turn the assembly over and set it down as shown in *Figure 100: Disconnect Wiring Harness from SDLC Card* below. Raise the enclosure body, and disconnect the internal cable harness at the SDLC board. Ensure the O-rings remain with the base when it is removed, and that they are not damaged.

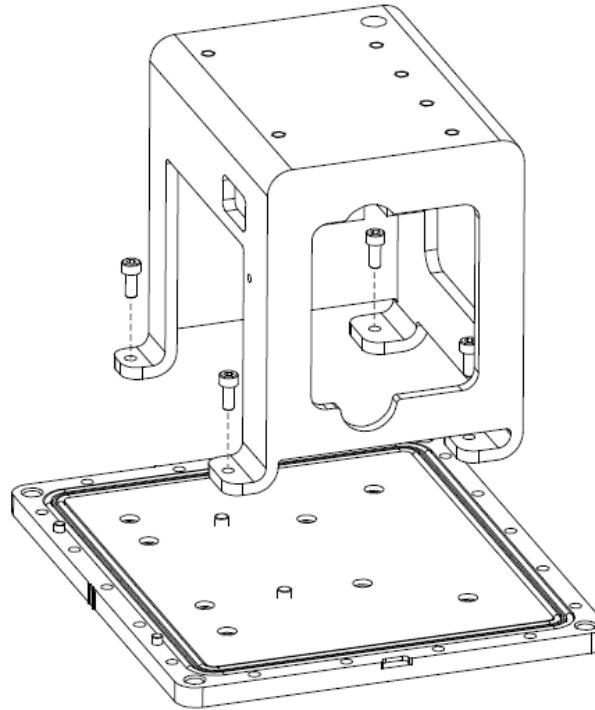
Figure 100: Disconnect Wiring Harness from SDLC Card



3. Lift the enclosure lid off the assembly to expose the IMU bracket, shown in *Figure 101: IMU Bracket* on the next page. Disconnect the harness at the SDLC card and remove.

Figure 101: IMU Bracket

4. Using a 3 mm hex bit, unscrew 4 mm screws and remove the IMU bracket with SDLC, as shown in *Figure 102: Remove IMU Bracket/SDLC* below.

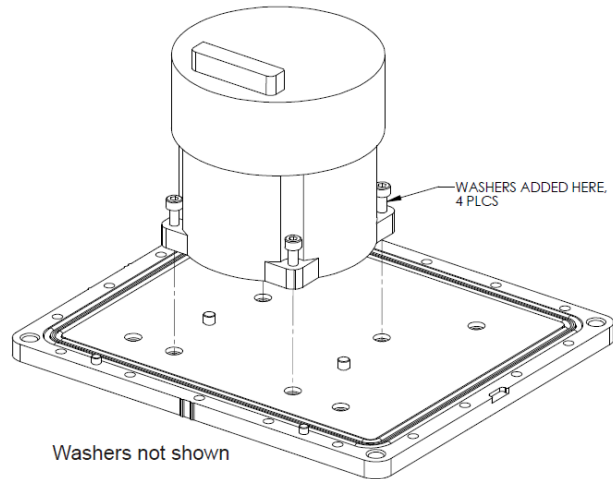
Figure 102: Remove IMU Bracket/SDLC

C.2 Install the LN-200 Sensor Unit

To install the LN-200 sensor unit in the Universal Enclosure:

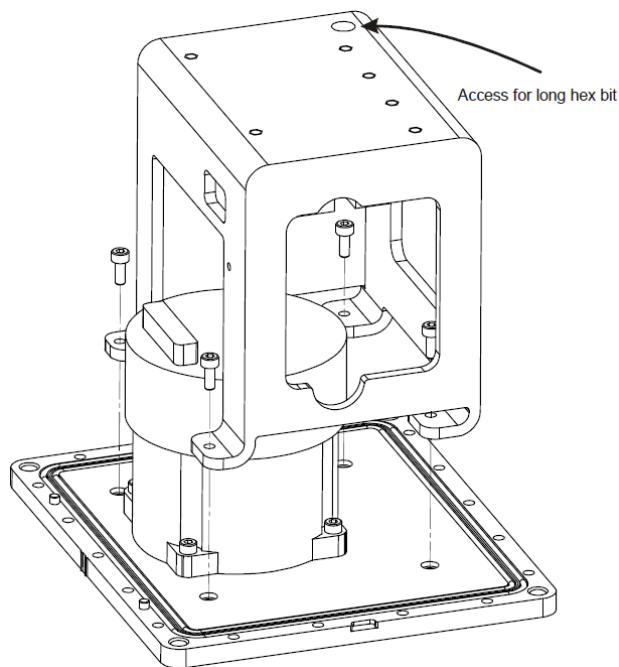
1. Using a 3 mm hex bit, remove original captive 6-32 screws and washers (4 each) from the LN-200 IMU. Add three washers under each of the original washers and fasten the IMU to the enclosure base, as shown in *Figure 103: Install LN-200 IMU to Base* on the next page. Use thread-locking fluid on each screw.

Figure 103: Install LN-200 IMU to Base



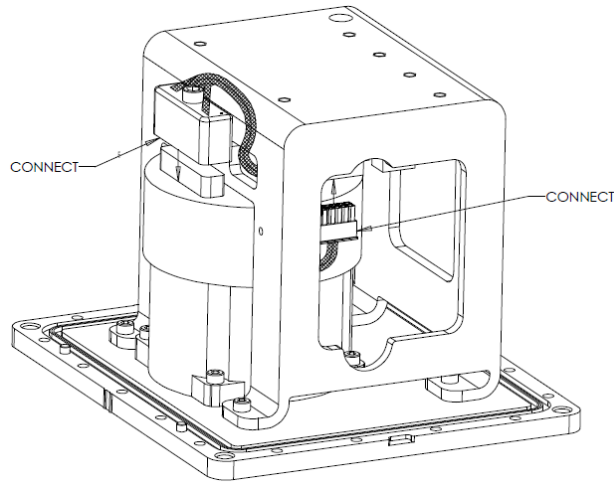
2. Using a long 3 mm hex bit, install the IMU bracket/SDLC to the base, as shown in *Figure 104: Install Bracket to Base* below. Use thread-locking fluid on each M4 screw.


Figure 104: Install Bracket to Base



3. Connect the cable harness to the board assembly and IMU, routing it as shown in *Figure 105: Making Connections* on the next page. Ensure latching of the cable connector housings and fasten the 6-32 screw at the IMU end using a 5/32" hex bit. Do not use thread-locking fluid and do not overtighten.

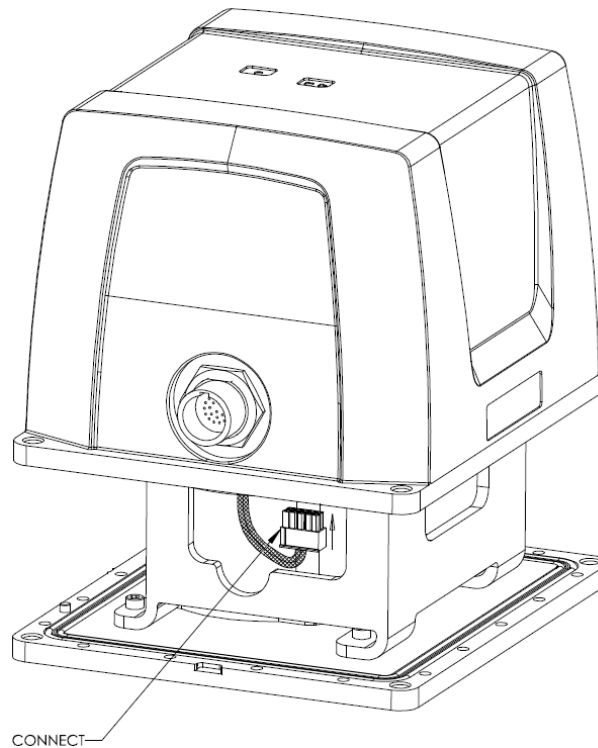
Figure 105: Making Connections



 Make sure the tape of the harness is positioned for maximum protection.

4. While carefully holding the body over the bracket, connect the internal cable harness to the board assembly, as shown in *Figure 106: Connect Internal Cable Harness* below.

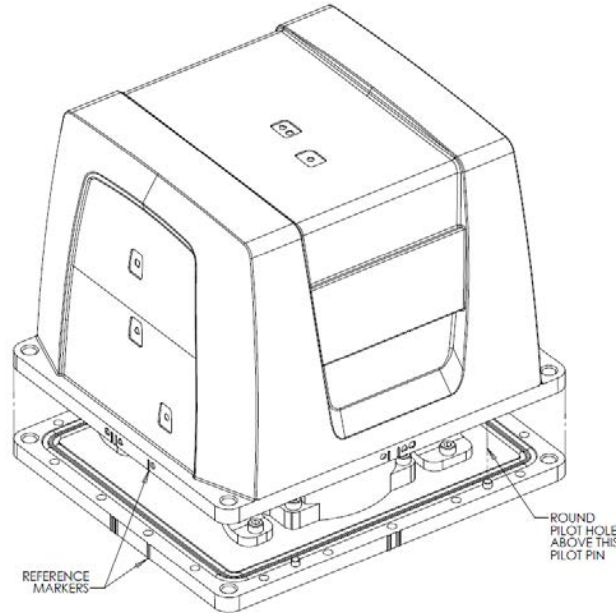
Figure 106: Connect Internal Cable Harness



5. Clean the surface of the enclosure body, where it will mate with the O-rings, using isopropyl

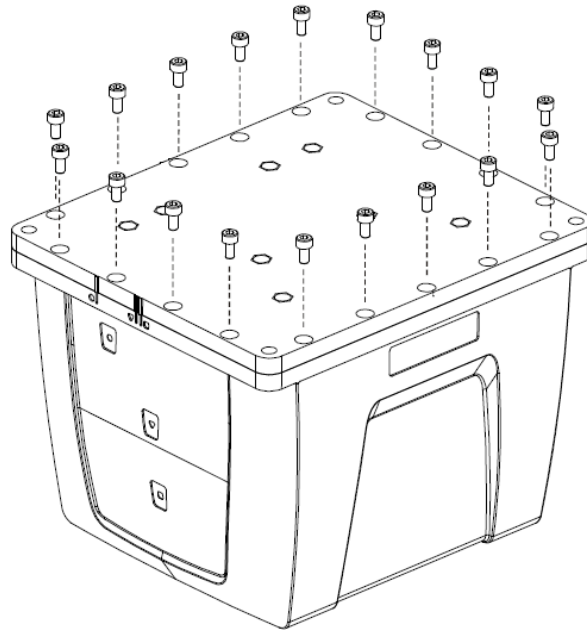
alcohol. While ensuring all wires will fit inside the bracket without being pinched, align the reference markers and pilot holes/screws of the enclosure body and base, and carefully lower the body onto the base, observing the O-rings and the alignment of corners. Start with the round pilot hole indicated in *Figure 107: Installing the Enclosure Body to the Base* below, then press the assembly into place.

Figure 107: Installing the Enclosure Body to the Base



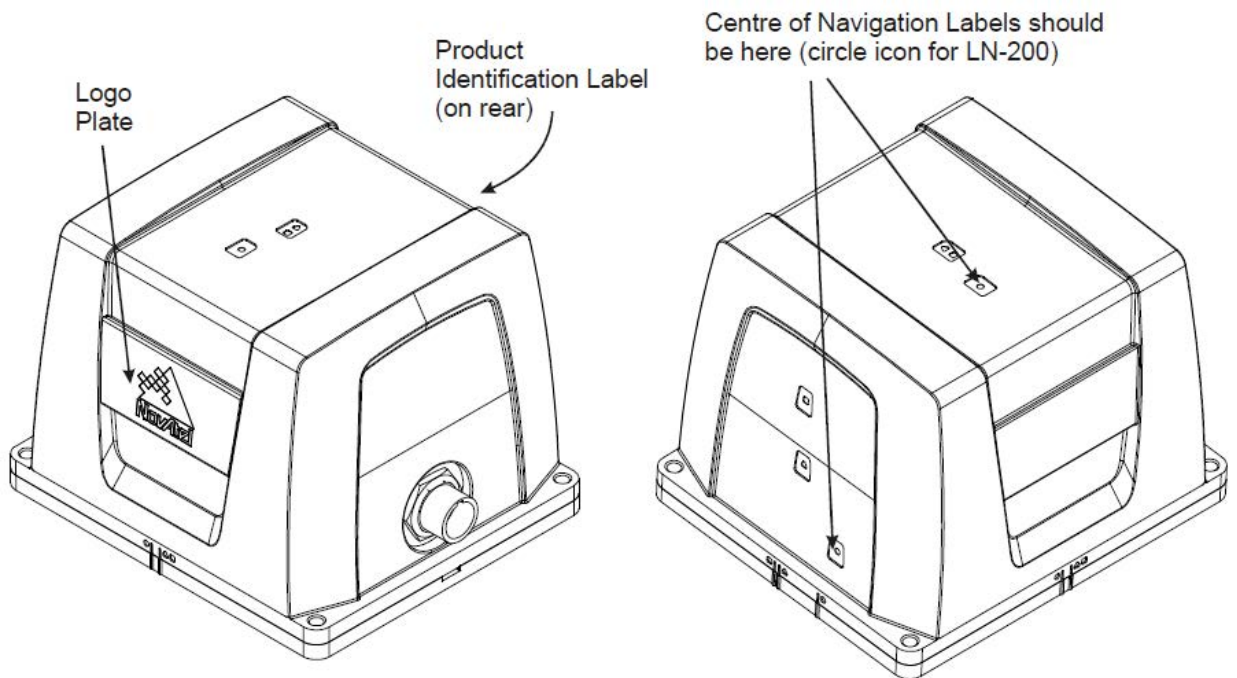
6. While squeezing and holding the enclosure body and base together to maintain tight contact, carefully turn the assembly over and place it on its top, as shown in *Figure 108: Screw Enclosure Base to Body* on the next page. Using a 3 mm hex bit, lightly fasten four equally spaced M4 screws to hold the parts together. Use thread-locking fluid on all screws. Install the remaining screws in similar fashion. Tighten all screws to 1.36-1.58 N-m (12-14 lb-in). Do not over-tighten.

Figure 108: Screw Enclosure Base to Body



7. Ensure the product identification label, the logo plate and the center of navigation labels are properly affixed and contain the correct information. The final assembled unit is shown in *Figure 109: Final Assembly* below.

Figure 109: Final Assembly



APPENDIX D HG1700 IMU in SPAN HG Enclosure

The following procedure provides the necessary information to install the HG1700 sensor into the SPAN HG Enclosure (NovAtel part number 01017898). The steps required for this procedure are:

- Disassemble the SPAN HG Enclosure
- Install the HG1700 Sensor Unit
- Make Electrical Connections
- Reassemble the SPAN HG Enclosure


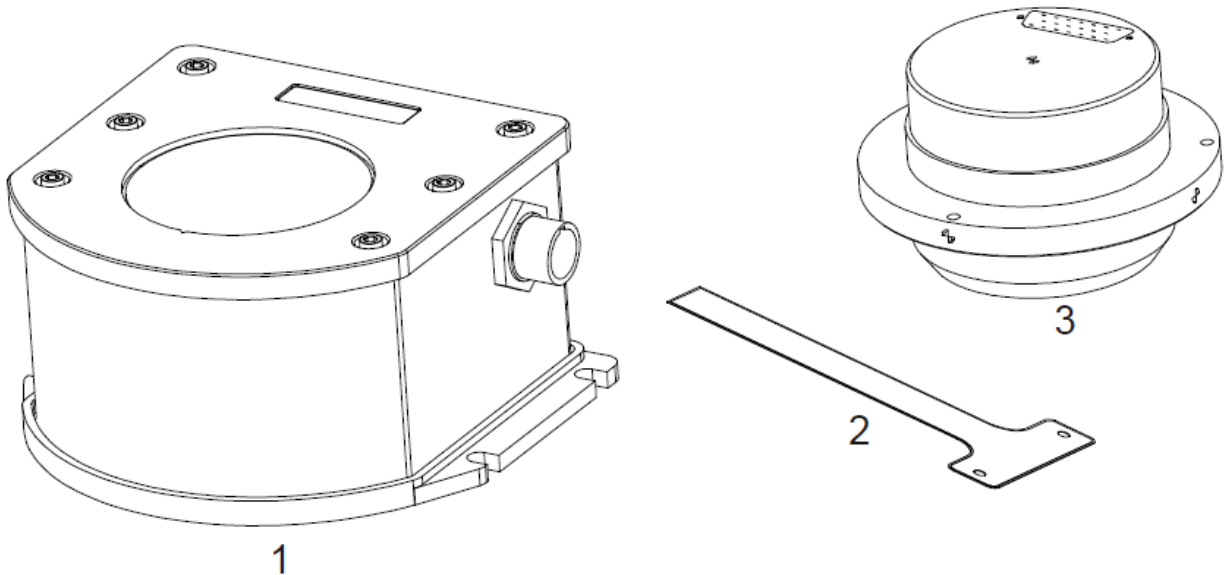
 Ensure you use a ground strap before installing the internal circuit boards. Do NOT scratch any surfaces of the unit.

Figure 110: Required Parts



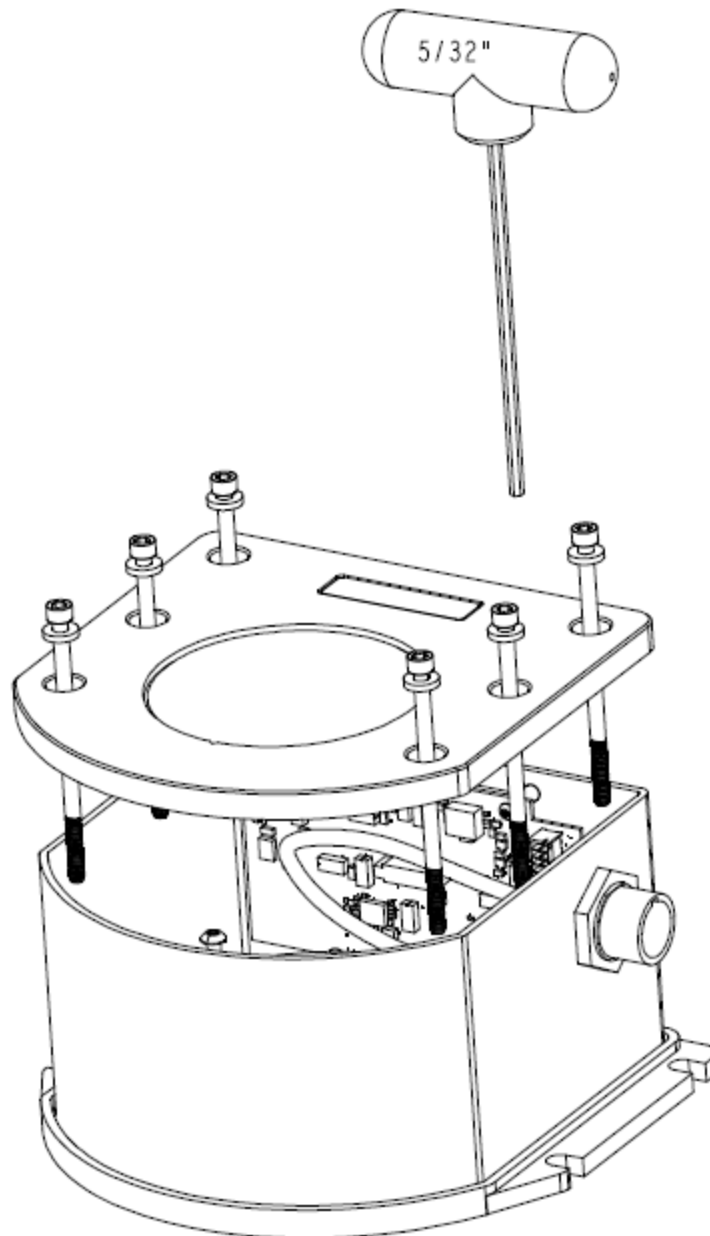
Reference	Description
1	SPAN IMU Enclosure
2	HG1700 Flex Cable
3	HG1700 Sensor Unit

D.1 Disassemble the SPAN IMU Enclosure

The SPAN IMU disassembly steps are as follows:

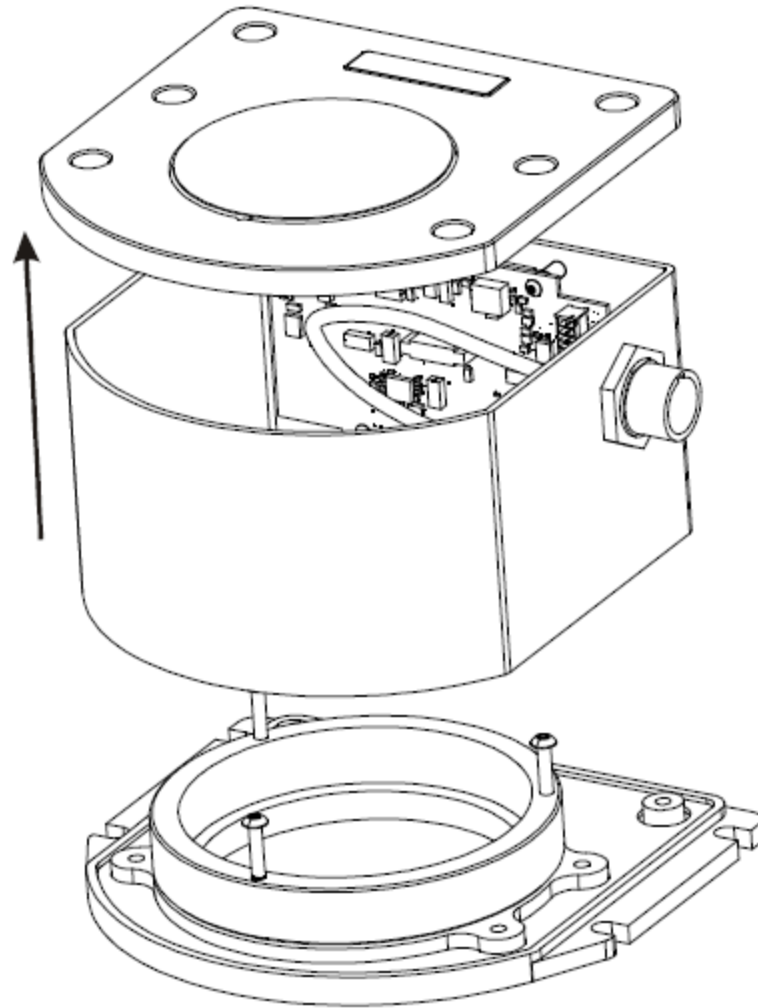
1. Remove the six bolts from the top cover using a hex key, as shown in *Figure 111: Bolts and Hex Key* on the next page:

Figure 111: Bolts and Hex Key



2. Set aside the bolts with their sealing washers.
3. Lift the top cover off the tube body and set it aside, as shown in *Figure 112: Lift Top Cover, Tube Body and 3 Ring Spacer Screws* on the next page.
4. Lift the tube body away from its base plate and set it aside.
5. Remove the 3 ring spacer screws and set them aside.

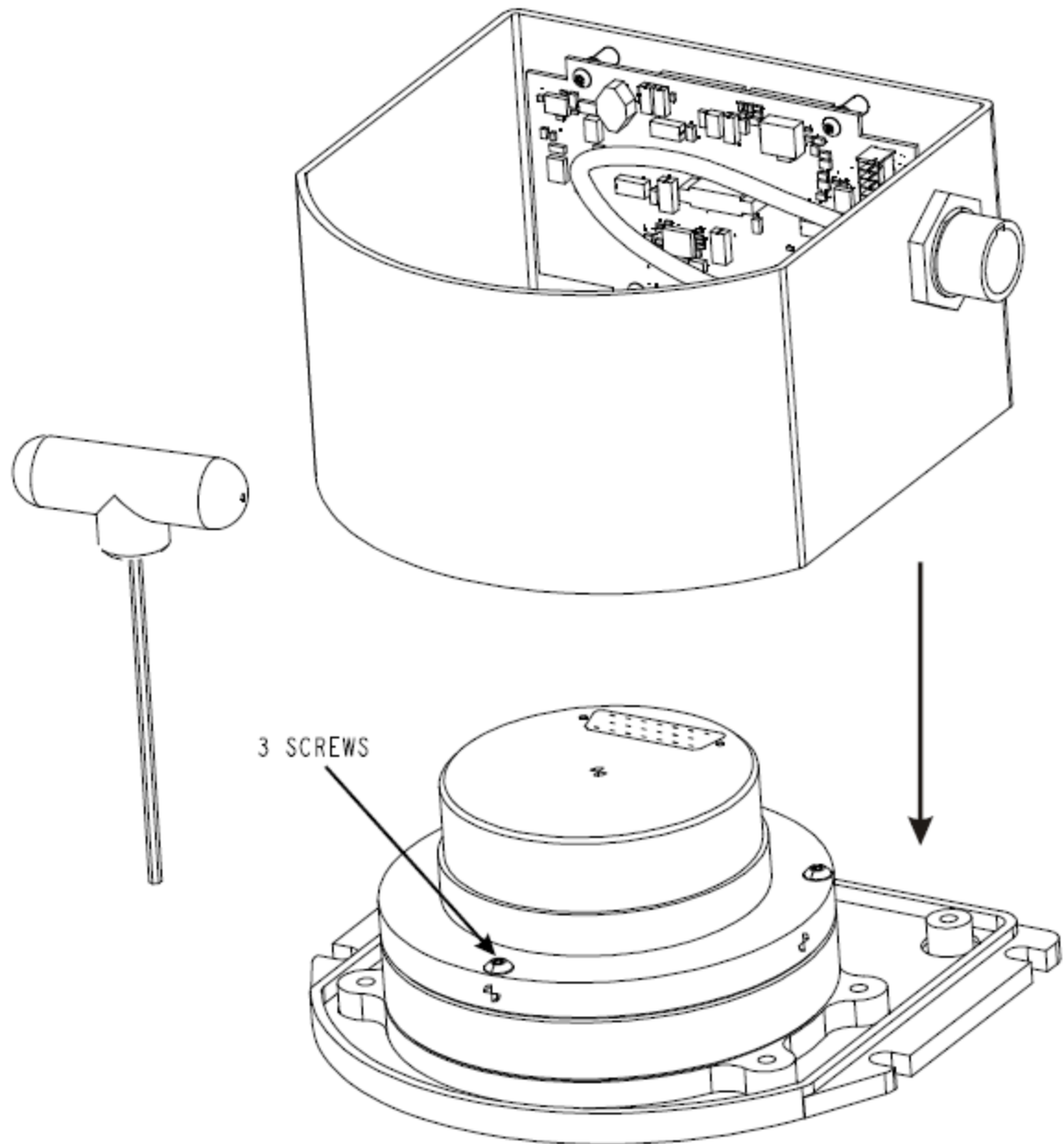
Figure 112: Lift Top Cover, Tube Body and 3 Ring Spacer Screws



D.2 Install the HG1700 Sensor Unit

To re-assemble the SPAN IMU with the HG1700 sensor, see *Figure 113: SPAN IMU Re-Assembly* on the next page and follow these steps:

1. Mount the HG1700 sensor with the attached #8 screws. Apply threadlock to the screw threads. Use a hex key to torque each screw to 10 in-lbs.
2. Fit the tube body over the HG1700 sensor and onto the base plate.

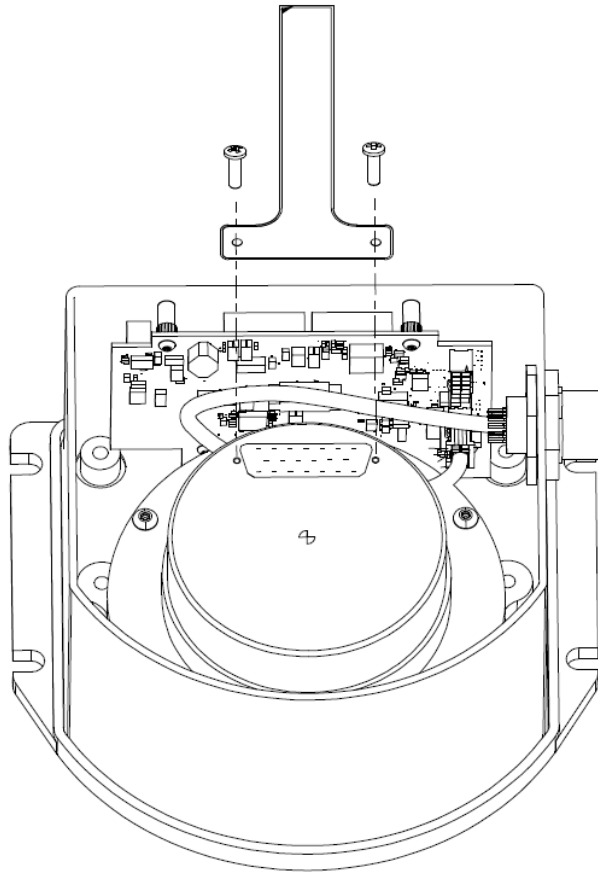
Figure 113: SPAN IMU Re-Assembly

D.3 Make the Electrical Connections

To make the electrical connections you need a 3/32" hex key, the flex cable and the partially assembled SPAN IMU from *Install the HG1700 Sensor Unit* on the previous page. Now follow these steps:

1. Attach the flex cable to the HG1700 sensor ensuring that all the pins are fully connected. Check also that the pins are fully seated and that the flex cable stiffener around the pins is not bent upward, see *Figure 114: Attach Flex Cable* on the next page.

Figure 114: Attach Flex Cable



2. Tighten the screws to 4 in-lbs.
3. Connect the opposite end of the flex cable to the corresponding connector on the IMU card ensuring that the contacts on the flex cable mate with the contacts on the connector, as shown in *Figure 114: Attach Flex Cable* above.
4. Check that the flex cable is locked in place.



Figure 115: Incorrect (Bowed) Flex Cable Installation below shows an incorrect installation of the flex cable where it is bowed in the middle. It will not operate properly in this position. *Figure 116: Correct (Flat) Flex Cable Installation* below shows the proper installation of the flex cable. Notice how the flex cable sits flush against the IMU surface.

Figure 115: Incorrect (Bowed) Flex Cable Installation

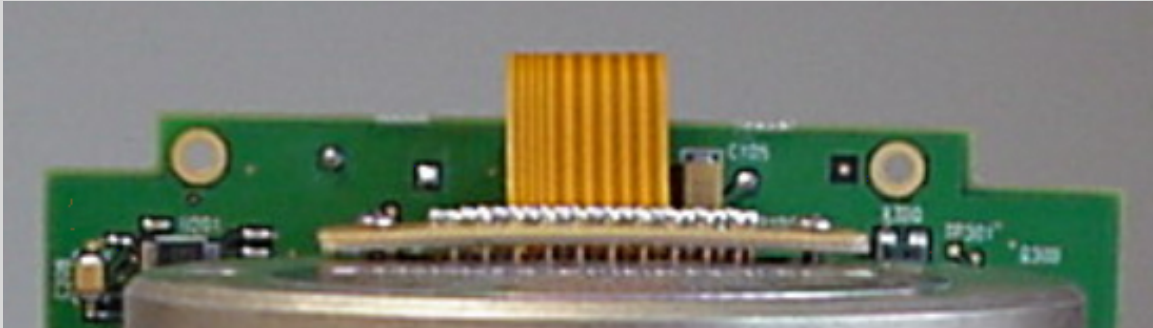
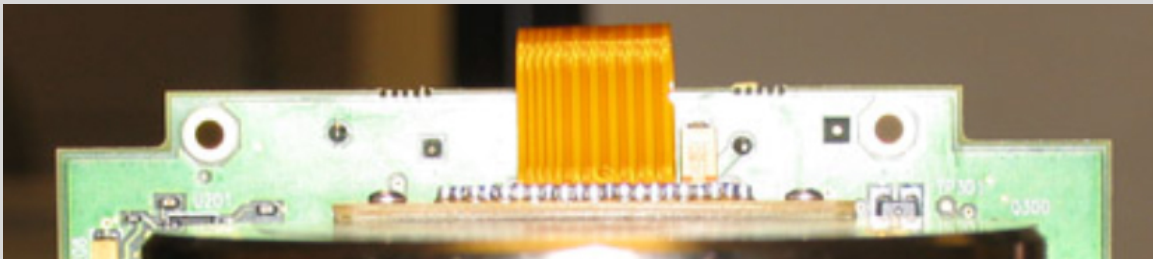


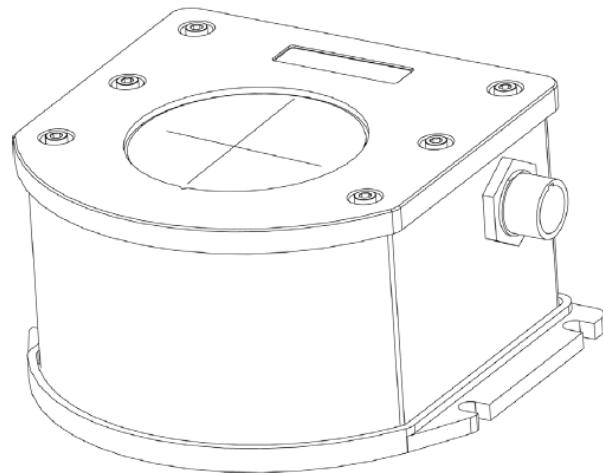
Figure 116: Correct (Flat) Flex Cable Installation



D.4 Re-Assemble the SPAN IMU Enclosure

Use a hex key to align the long bolts with the threaded holes in the base, as shown in *Figure 111: Bolts and Hex Key* on page 225. Apply threadlock to threads. Finger tighten all bolts and torque them in a cross pattern to 12 in-lbs. The fully assembled IMU enclosure is shown in *Figure 117: HG1700 SPAN IMU* on the next page.

Figure 117: HG1700 SPAN IMU



APPENDIX E LN-200 IMU in SPAN IMU Enclosure

The following procedure provides the necessary information to install the LN-200 sensor (NovAtel part number 80023515) into the SPAN IMU enclosure (NovAtel part number 01017656) using the LN-200 wiring harness (NovAtel part number 01017655). The steps required for this procedure are:

- Disassemble the SPAN IMU Enclosure
- Install the LN-200 Sensor Unit
- Make Electrical Connections
- Reassemble the SPAN IMU Enclosure


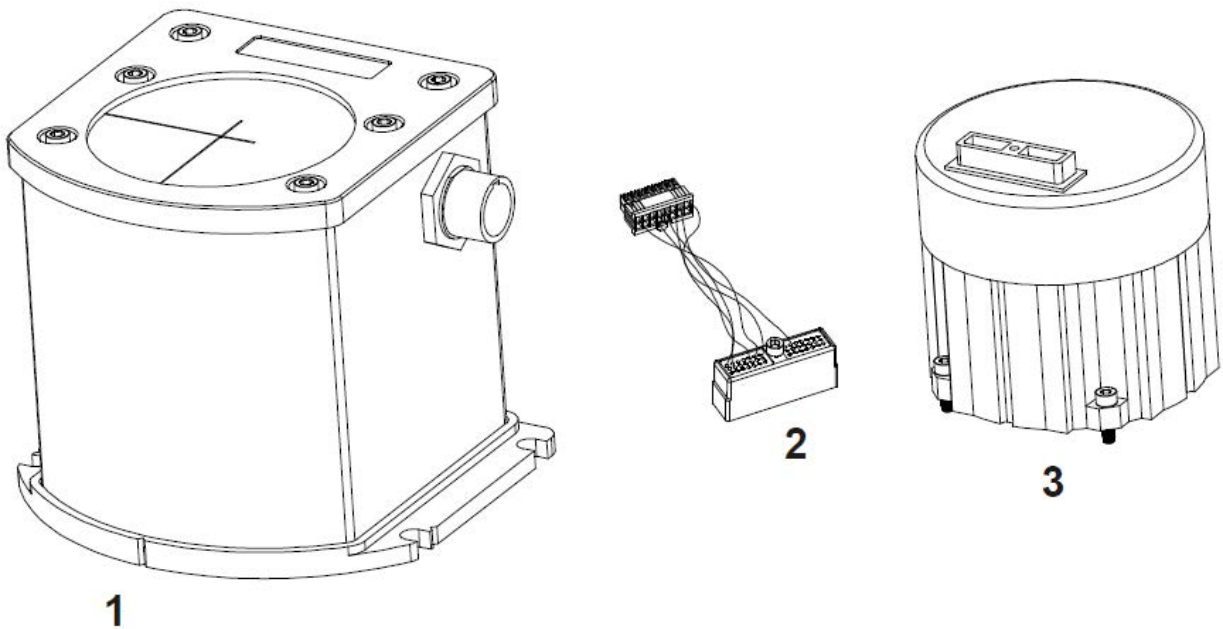
 **Important!** Ensure you use a ground strap before installing the internal circuit boards. Do NOT scratch any surfaces of the unit.

Figure 118: Required Parts



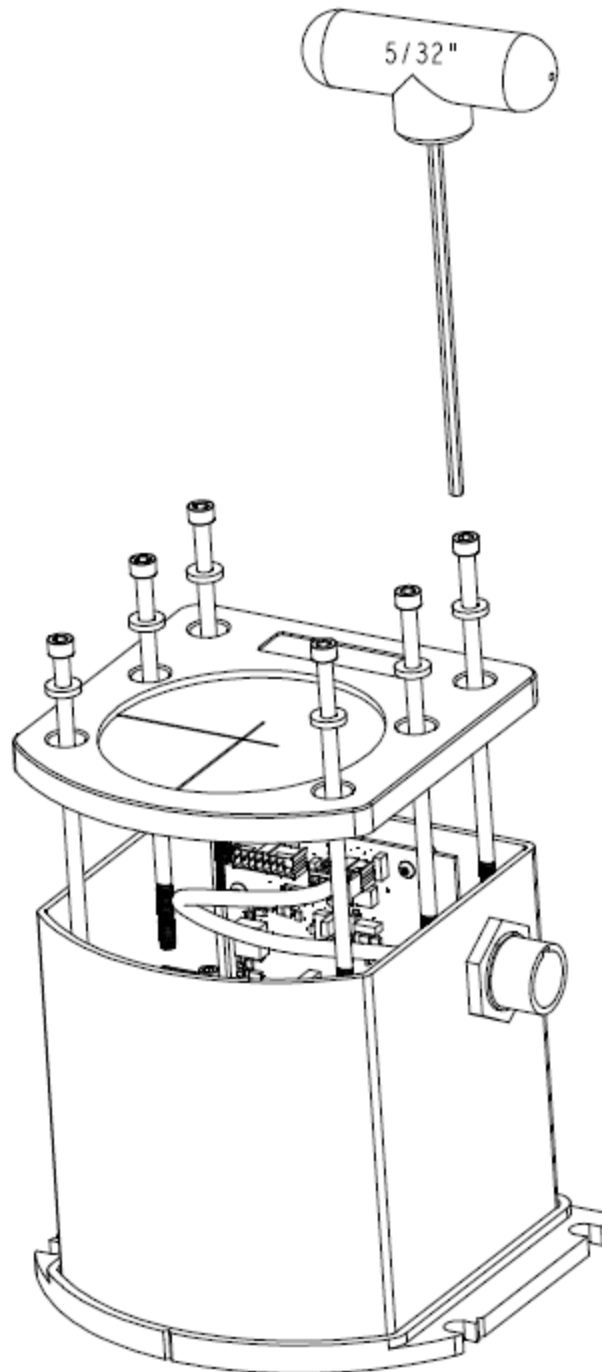
Reference	Description
1	SPAN IMU Enclosure
2	LN-200 Wiring Harness
3	LN-200 Sensor Unit

E.1 Disassemble the SPAN IMU Enclosure

The SPAN IMU disassembly steps are as follows:

1. Remove the six bolts from the top cover using a hex key, as shown in *Figure 119: Bolts and Hex Key* below:

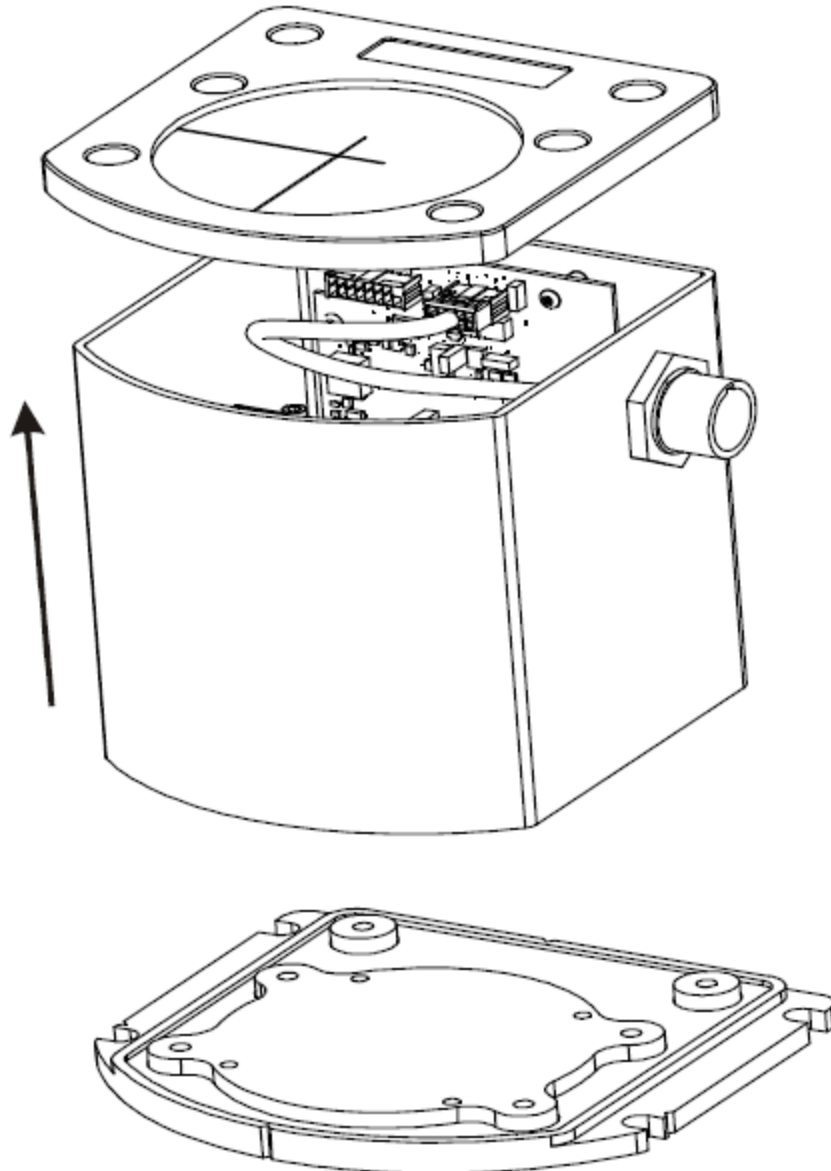
Figure 119: Bolts and Hex Key



2. Set aside the bolts with their sealing washers.
3. Lift the top cover off the tube body and set it aside.
4. Lift the tube body away from its base plate and set it aside, as shown in *Figure 120: Lift Top*

Cover and Tube Body on the next page.

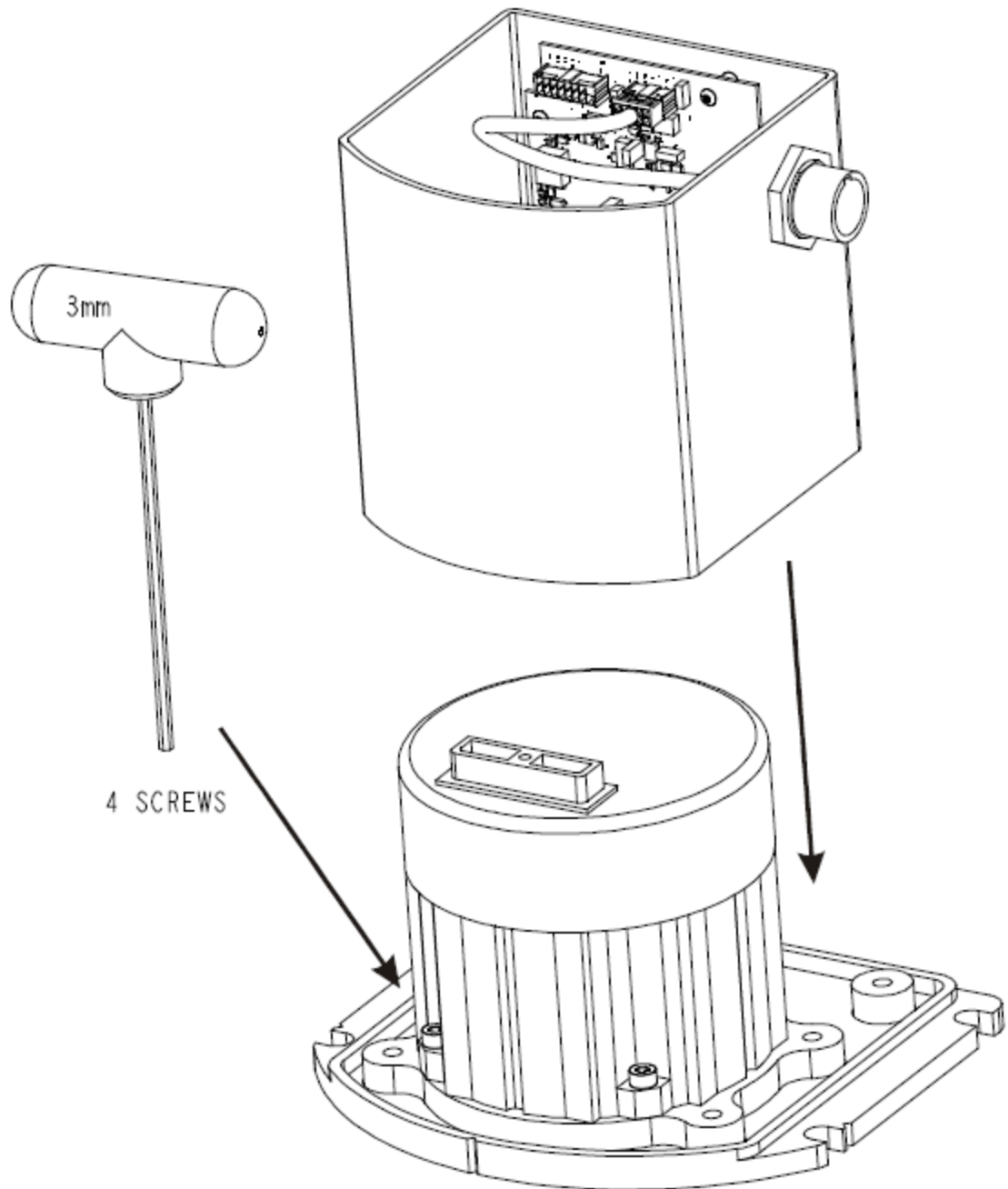
Figure 120: Lift Top Cover and Tube Body



E.2 Install the LN-200 Sensor Unit

To install the LN-200 sensor, follow these steps:

1. Mount the LN-200 sensor with the attached M4 screws. Apply threadlock to the screw threads. Use a hex key to torque each screw to 10 in-lbs.
2. Fit the tube body over the LN-200 sensor and onto the base plate.

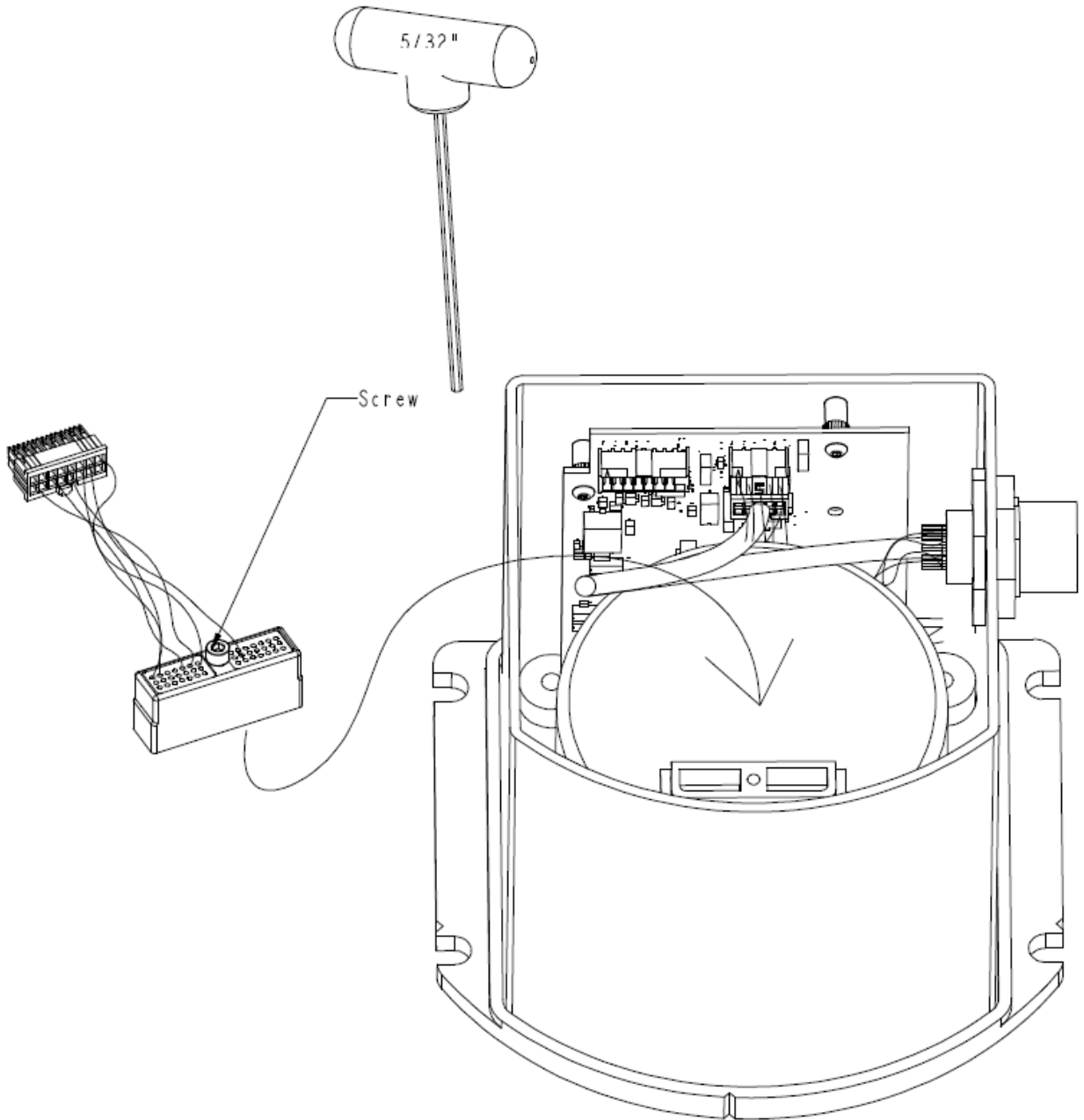
Figure 121: SPAN IMU Re-Assembly

E.3 Make the Electrical Connections

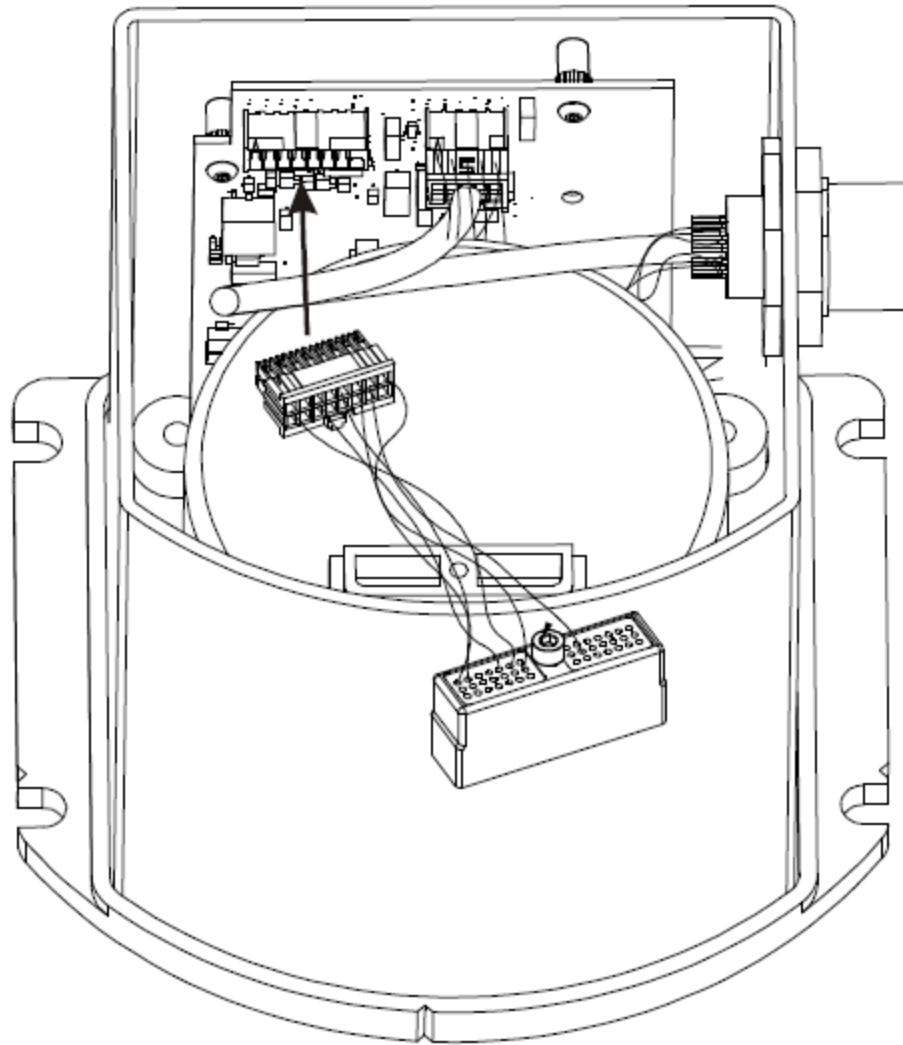
To make the electrical connections you will need a 3/32" a hex key, the wiring harness and the partially assembled SPAN IMU from *Install the LN-200 Sensor Unit* on the previous page. Now follow these steps:

1. Attach the LN-200 wire harness to the mating connector on the LN-200. Check that the connector is fully seated, as shown in *Figure 122: Attach Wiring Harness* on the next page.

Figure 122: Attach Wiring Harness



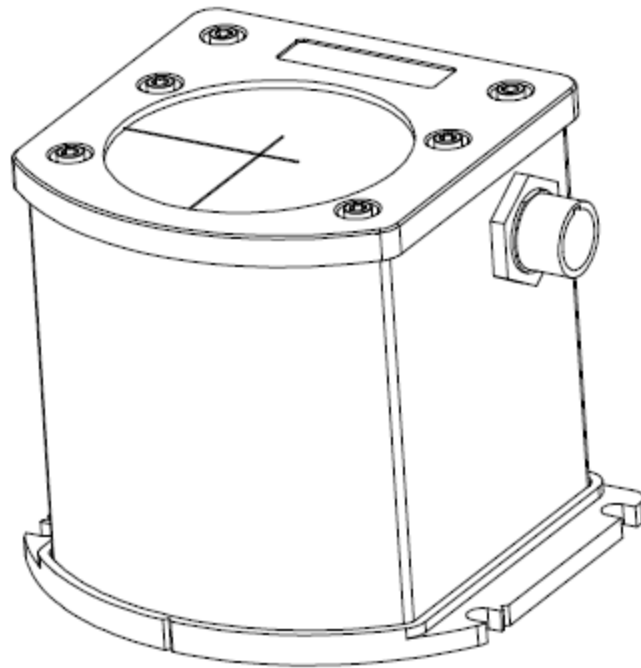
2. Connect the Samtec connector at the other end of the wiring harness to the corresponding connector on the internal IMU card, as shown in *Figure 123: Attach Samtec Connector* on the next page. Ensure that the connector is locked in place.

Figure 123: Attach Samtec Connector

E.4 Re-Assemble the SPAN IMU Enclosure

Use a hex key to align the long bolts with the threaded holes in the base, as shown in *Figure 119: Bolts and Hex Key* on page 232. Apply threadlock to threads. Finger tighten the 6 bolts then torque them in a cross pattern to 12 in-lbs. The fully assembled IMU enclosure is shown in *Figure 124: LN-200 SPAN IMU* on the next page.

Figure 124: LN-200 SPAN IMU



APPENDIX F Frequently Asked Questions

1. How do I know if my IMU is connected properly?
 - a. Refer to the **VERSION** log. If your IMU is communicating with a SPAN enabled receiver, the IMU details will be included in the log.
 - b. When powered, the HG-1700 IMU makes a noticeable humming sound. If no sound is heard, check that the cable between the receiver and IMU is connected properly.
 - c. Most IMUs do not make noise. Check that the IMU interface cable is properly connected to the receiver.
For the IMU-ISA-100C, IMU-FSAS, IMU-CPT, IMU-HG1900, IMU-LN200, IMU- μ IMU and IMU-KVH1750, ensure the IMU interface cable is connected to an RS-422 capable port and the port is configured to use RS-422.
 - d. If the cable is connected properly, check the flex cable mounted on top of the IMU. Refer to the instructions in this manual on proper IMU installation to ensure that the cable is seated properly on the IMU pins. See *HG1700 IMU in Universal Enclosure* on page 206 or *LN-200 IMU in Universal Enclosure* on page 217 for more details.
 - e. Check the input power supply. A minimum of 12V should be supplied to the system for stable IMU performance. The supply should also be able to output at least 12W over the entire operating temperature range.
2. What is the minimum configuration I need to do to get the system running?
 - a. Set the IMU type and IMU communication port with the **CONNECTIMU** command.
 - b. Specify the translational offset between the IMU center of navigation and the primary GNSS antenna phase center with the **SETINSTRANSULATION** command.
 - c. Specify the rotational offset between the IMU Body frame and the Vehicle frame, with the **SETINSROTATION** command.
3. What types of IMUs are supported?

SPAN currently supports the following IMUs:

 - ADIS-16488 from Analog Devices
 - G320 from Epson
 - HG1700, HG1900 and HG1930 from Honeywell
 - IMU-FSAS for iMar
 - IMU-KVH1750 and IMU-CPT from KVH
 - ISA-100C and μ IMU from Northrop Grumman LITEF
 - LN-200 from Litton
 - STIM300 from Sensoror

Use the **CONNECTIMU** command to specify the type of IMU used.
4. Why don't I have any INS data?
 - a. By default, the raw IMU data begins flowing at system start up. If there is no INS data, check that the system has been configured properly. See question 3 above.

- b. If the **INSCOMMAND** command has been set to **START_FINE_TIME**, the RAWIMU logs are not available until the system has solved for time. This requires that an antenna is attached and satellites are visible to the system. You can verify that time is solved by checking the time status in the header of any standard header SPAN log such as BESTPOS. When the time status reaches FINETIME, the inertial filter starts and IMU data is available.

5. How can I access the inertial solution?

The GNSS+INS solution is available from a number of specific logs dedicated to the inertial filter. The **INSPOS** log, **INSPVA** log, **INSVEL** log, **INSSPD** log and **INSATT** log are the most commonly used logs for extracting the INS solution. These logs can be logged at any rate up to the rate of the IMU data (100, 125 or 200 Hz depending on your IMU model). The solution can also be triggered by the mark input signal by requesting the **MARKxPVA** logs.

6. Can I still access the GNSS-only solution while running SPAN?

The GNSS only solution used when running the OEM7 receiver without the IMU is still available when running SPAN. Logs such as the **PSRPOS** log and **RTKPOS** log are still available. The **BESTGNSSPOS** log is also available to provide the best available GNSS only solution. Any non-INS logs should be logged at a maximum rate of 5 Hz when running SPAN. Only INS-specific logs should be logged at rates higher than 5 Hz when running SPAN.

7. What will happen to the INS solution when I lose GNSS satellite visibility?

When GNSS tracking is interrupted, the INS solution bridges through the gaps with what is referred to as free-inertial navigation. The IMU measurements are used to propagate the solution. Errors in the IMU measurements accumulate over time to degrade the solution accuracy. For example, after one minute of GNSS outage, the horizontal position accuracy is approximately 2.5 m when using an HG1700 AG58. The SPAN solution continues to be computed for as long as the GNSS outage lasts, but the solution uncertainty increases with time. This uncertainty can be monitored using the **INSSTDEV** log or **INSSTDEVS** log.

8. Why can SPAN not align with my IMU-KVH1750?

SPAN requires that the IMU-KVH1750 be configured with non-default settings. If you have obtained your IMU-KVH1750 directly from KVH, or have manually changed the IMU configuration, refer to *IMU Direct Connection* on page 20 for information about configuring the IMU for operation with SPAN.



Further details on the command and logs in this section are available in the OEM7 Commands and Logs Reference Manual (OM-20000169).

APPENDIX G Replacement Parts for SPAN

The following are a list of the replacement parts available. Should you require assistance, or need to order additional components, contact your local NovAtel dealer or Customer Support.

NovAtel Part	Part Description	
IMU-CPT		
IMU-FSAS-EI		
IMU-H1900-CA50		
IMU-H1930-CA50		
IMU-H58		
IMU-H62		
IMU-IGM-A1		
IMU-IGM-S1		
IMU-ISA-100C		
IMU-KVH1725		
IMU-KVH1750		
IMU-LN200		
IMU- μ IMU	IMUs (see <i>Table 1: SPAN-Compatible IMU Models</i> on page 15 for details)	
OEM-IMU-ADIS-16488		
OEM-IMU-G320		
OEM-IMU-HG1900		
OEM-IMU-ISA-100		
OEM-IMU-ISA-100C		
OEM-IMU-LN200		
OEM-IMU-STIM300		
OEM-IMU- μ IMU		
UIMU-H58		
UIMU-H62		
UIMU-LN200		
OEM719		Receivers
OEM729		
OEM7700		
OEM-IMU-ADIS-MIC		MEMS Interface Card (MIC) for MEMS IMUs
OEM-IMU-STIM-MIC		

NovAtel Part	Part Description
OEM-IMU-ISA-UIC	Universal IMU Controller (UIC) for OEM-IMU-ISA-100C / OEM-IMU-ISA-100
IMU Interface Cables	
01018388	iIMU-FSAS IMU with Odometer interface cable
01018966	IMU-CPT IMU interface cable
01018977	Universal IMU Enclosure Interface cable
01019007	ADIS IMU Cable Kit
01019013	IMU-IGM Stack Up Cable
01019015	SPAN-IGM Auxiliary Port Interface Cable
01019016	IMU-IGM Interface Cable
01019040	SPAN-IGM/IMU-IGM Bracket Kit
01019174	OEM-IMU-STIM300 Cable
01019211	IMU-KVH1750 Interface Cable
01019319	IMU Enclosure Interface Cable
01019393	UIC to ISA-100C Interface Cable
01019760	UIC to μ IMU Interface Cable
01019762	UIC to HG1900 Interface Cable
01019763	UIC to LN200 Interface Cable
60723136	IMU Enclosure Power Cable
60723137	IMU Enclosure Wheel Data Cable

